This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

600030184M

C
16666 e 40

600030184M

C
16666 e 40

THE

NERVOUS SYSTEM

OF THE

HUMAN BODY.

THIRD EDITION.

WITH ADDITIONS.

THE

NERVOUS SYSTEM

OF THE

HUMAN BODY:

AS EXPLAINED IN A SERIES OF

PAPERS READ BEFORE THE ROYAL SOCIETY OF LONDON.

WITH AN APPENDIX OF

CASES AND CONSULTATIONS ON NERVOUS DISEASES.

BY

SIR CHARLES BELL, K.G.H., F.R.S.S. L. & E.

PROFESSOR OF SURGERY IN THE UNIVERSITY OF EDINBURGH, RETIRED MEMBER OF
THE COUNCIL AND PROFESSOR OF ANATOMY AND SURGERY ROYAL COLLEGE OF SURGEONS
OF LONDON, FELLOW OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH,
AND LATE SENIOR SURGEON OF THE MIDDLESEX HOSPITAL.

RADCLIFFE LIB
UNIVERSITY
13 APR 97
MUSEUM
OXFORD

THIRD EDITION.

WITH SIXTEEN HIGHLY FINISHED STEEL ENGRAVINGS, AND
THREE ADDITIONAL PAPERS ON THE NERVES
OF THE ENCEPHALON.

LONDON:
HENRY RENSHAW, 356, STRAND.
MDCCCXLIV.

NOTE.

THE present volume is not a new edition of the work. It differs only in having three *additional papers*,—those read to the Royal Society of Edinburgh.

The Nervous System is now traced from the extreme branches of the sensitive and motor nerves to their termination inwards in the convolutions of the cerebrum. The respiratory nerves have been distinguished from these, thus opening a subject of great interest.

These papers, read in succession, and at intervals, according as the author, engaged in an arduous profession, could find time for the prosecution of such subjects, present a series which requires little comment. The evidence of originality is open to every unprejudiced mind. The author has neither been turned aside, nor hurried into premature conclusions. The principle which directed him in these inquiries is stated in the very beginning, and step by step the reader may follow the observations and dissections by which the System has been made out.

PREFACE.

THE more important endowments of life are bestowed upon the Nervous System, which embraces the Brain, the organs of the Senses, and the instruments of Volition. Through it are also communicated the sensibilities which control the instinctive or *automatic* movements. Thus it governs the actions of volition, as well as those movements which are appropriated to the vital organization.

The Nervous System is therefore that part of Anatomy in which are to be discovered not only the different properties of the living fibre, but also the relations of the organs to each other, and the dependence of the muscular system upon those organs.

The knowledge, then, of what is termed the Economy of an Animal Body is to be acquired only by an intimate acquaintance with the distribution and uses of the nerves; and this knowledge of the natural relations leads directly to the comprehension of the signs of disturbed function, or the symptoms of disease.

The present volume contains many proofs that, by the advancement of anatomical science, we are enabled to make important practical distinctions; and these give value to that which can never be without interest to a student of nature. All the proofs of design, of relation, of prospective contrivance, which are deduced from the mechanical parts of the animal frame, are as nothing to the instances which the contemplation of the Nervous System affords. The relations to external nature, the sources of enjoyment, the provisions against injuries, the order and symmetry adapted to bestow motion and action, visible in the Nervous System, supply accumulated proofs of benevolence, as well as of divine intelligence, in the construction of our bodies.

Perhaps this volume should not be called a third edition, at least as implying emendations on what has been already published; for up to the present time it has been impossible to present the subject in a strictly systematic form: and it may be necessary to state something of the progress of these inquiries, in order to account for the peculiar form of the work.

The author began his public labours as an assistant lecturer to his brother John Bell, who gave up to him that part of the course of Anatomy which treats of the Nerves; and he advised him to demonstrate the relations of the brain to the base and spinal marrow, instead of cutting it in horizontal sections. The intelligent student will at once perceive, that much of what is contained in this volume may be traced to the aspect in which the author was accustomed during all his after labours to look upon the relations of the brain to the rest of the Nervous System.

The views now presented rose very gradually to his mind; but it should be understood, that, during the period of his most successful teaching in London, the essential parts of this system, and the governing principle of the whole, were taught by him to full classes from the years 1811 till 1833.* In the year 1821, he presented his first paper on the Nervous System to the Royal Society,—not that the opinions there expressed were new to him, but because he had found them confirmed by experiments which could not be overlooked or thrown aside, if the rules of the Society were to be maintained. After struggling for many successive years with the difficulties in the demonstration of the nerves of the body, he had recourse to their origins to find out their uses. He first examined the spinal nerves in all the course of the spinal marrow, and observed their exact resemblance to each other in every particular. He then, by experiment, proved that their roots had different powers, and that the spinal nerves really were what their anatomy had indicated, double nerves. Strengthened in his conviction that the anatomy, if properly pursued, would bring symmetry out of apparent confusion, he set about the examination of the nerves of the encephalon, and found that the fifth nerve of the brain was the only one which, from having two roots, could bestow upon the head those double functions of sensation and motion which were given to the body through the spinal nerves. He then selected the nerves of the face for experiment, in order to demonstrate to others what he had, by anatomy, convinced himself to be their function. Had he commenced with experiments, they would have misled him. He would have supposed the fifth nerve to be the nerve of sensibility, and the portio dura to be the sole nerve of motion. His main object was to make a sufficient impression on those who had resigned all hope of any improvement in this part of anatomy. He had before ascertained that the fifth was a double nerve, a nerve of motion to the muscles of the jaws as well as a nerve of sensation; and that the portio dura of the seventh was more than a voluntary muscular nerve, that it belonged to the respiratory system, and that this was the explanation of its running apart from the fifth.

---

* For an account of the succession in which the observations were made public, see a Note in the Appendix.

The publication of the first paper quickly drew attention to a subject which had ceased to be of interest, from the hopelessness of improvement. The more liberal members of the profession were not backward in communicating to the author occurrences in practice now reconcilable with the anatomy; and the deductions originally drawn from the structure became more and more confirmed.

Eight papers were in succession printed in the Royal Society's Transactions. It would be a great labour to recast the whole of these, so as to present them in a strictly systematical form; and, if not misled by the partiality of friends, the author believes that the observations will be more acceptable in their original form.

As he has commenced the volume with an introductory view, there must necessarily be repetitions. It is hoped, however, that, in a subject of some intricacy, and surely of much interest, these repetitions may not be superfluous.

The Appendix contains a series of cases and observations, in illustration of the demonstrations of the functions of the nerves; they form the best comment on the text, and furnish proofs of the necessity of distinguishing the offices of the different nerves.

CONTENTS.

INTRODUCTION—

History of the Anatomy of the Nervous System, . . 1

GENERAL VIEW OF THE NERVOUS SYSTEM, . . . 13–31

Of the Connection of the Nerves of Sensation and of Voluntary Motion with the Spinal Marrow, and of the relation between the Spinal Marrow and the Cerebrum, . . 19

Union of the Columns of Sensation in the Medulla Oblongata, 30

Do. of Motion, ... 30

Why the author has divided the system into Regular and Irregular Nerves, ... 31

ON THE NERVES—A VIEW OF THEIR STRUCTURE AND ARRANGEMENT, WITH AN ACCOUNT OF SOME EXPERIMENTS ILLUSTRATIVE OF THEIR FUNCTIONS, ... 33–45

Intricacy of the Nervous System, ... 34

Object of the paper on the Nerves of Respiration, . . 36

The Nerves of the Animal Frame are complex in proportion to the variety of Functions which the parts have to maintain, ... 37

The Nerves divided, in proportion to the complexity of Organization, into two Systems, the Simple and Uniform, and the Irregular and Complex, . . . 39

More particularly of the Respiratory Nerves according to their Functions, ... 42

1. Par Vagum, ... 43
2. Portio Dura of the Seventh, . . . 43
3. Glosso-Pharyngeal Nerve, . . . 44
4. Superior Respiratory Nerve of the Trunk. Spinal accessory, ... 44
5. Great internal Respiratory or Phrenic Nerve, . 44
6. External Respiratory Nerve, . . . 45

On the Nerves of the Face—In which it is shewn that two sets of Nerves, hitherto supposed to be similar, differ in Structure, Sensibility, and Function, . 46–63

Of the Trigeminus or Fifth Pair, the Nerve of Sensation and Mastication, ... 47
Of the Portio Dura of the Seventh Nerve, the Motor and Respiratory Nerve of the Face, . . . 48
Experiments on the Nerves of the Face to ascertain the use of the Portio Dura, ... 52
Of the Functions of the Trigeminus, . . . 57
Further remarks on Diseases of Nerves of the Face, . 63

On the Nerves of the Face, . . . 71–79

Of the Motor or Manducatory portion of the Fifth Nerve, . 77
Ramus Buccinalis Labialis, ... 79

On the Nerves which associate the Muscles of the Chest in the actions of Breathing, Speaking and Expression, . 89–138

On the Nerves of Respiration, . . . 39
Of Respiration, ... 90
Of the Muscles of the Trunk, which are brought in aid of the common Respiratory Muscles, . . . 97
The Action of the Muscles of the Neck shewn to be necessary both for Respiration and Circulation, . . 99
Origins of the Respiratory Nerves, . . . 102
Comparative view of these Nerves, . . . 109
Their Functions further illustrated, . . . 111
Of the seat of that power which controls the Respiratory Motions, ... 117
On the Actions of Respiration in those who have suffered Fracture of the Spine at the lower cervical vertebræ, . 122
Conclusion, ... 128
Paralytic and Convulsive Affections of the Respiratory Nerves, 131
Some additional Notes on the Nerves of Respiration, . 133
Of Smelling, as influenced by the Portio Dura of the Seventh Nerve, ... 134
These Respiratory Nerves are Organs of Expression, . 138

On the Motions of the Eye—In illustration of the Uses of the Muscles and Nerves of the Orbit, . . 145–196

Part I.—*Of the Muscles and Frame-work which surround the Eye-ball,* 146
Motions of the Eye-ball and Eye-lids, . . . 147
Of the Actions of the Muscles of the Eye, and their natural Classification, ... 152

Experimental inquiry into the action of these Muscles, . 156
Of the two conditions of the Eye, its state of Rest and of Motion, ... 160
Of the expression of the Eye, and of the actions of the oblique Muscles in disease, ... 165
PART II.—*Of the Nerves of the Orbit,* . . . 169
Of the function of the Ophthalmicus, a division of the Fifth Nerve, ... 170
Of the Nerves performing the Involuntary Motions, . 173
Of the Fourth Nerve, as performing an involuntary Motion, 176
Of the Voluntary Nerves, ... 180

OF THE NERVOUS CIRCLE WHICH CONNECTS THE VOLUNTARY MUSCLES WITH THE BRAIN, . . . 193–203

OF THE FUNCTIONS OF SOME PARTS OF THE BRAIN, AND OF THE RELATION BETWEEN THE BRAIN AND THE NERVES OF MOTION AND SENSATION, ... 207–227
Of the Striated Septa in the Medulla Oblongata and Pons Varolii, ... 211
The Posterior Tract, ... 215
Decussation of the Posterior or Sensitive tracts, . . 218
Origin of the Posterior Roots of the Spinal Nerves, and their relation to the Decussation of the Posterior Column, . 219
Origin of the Sensitive Root of the Fifth Nerve, and its relation to the Spinal Marrow, . . . 220
Further examination of the relation between the Brain and the Spinal Marrow, ... 224

ON THE RELATION BETWEEN THE NERVES OF MOTION AND OF SENSATION, AND THE BRAIN; AND PARTICULARLY ON THE STRUCTURE OF THE MEDULLA OBLONGATA AND THE SPINAL MARROW, ... 231–237
Union of the lateral Columns in the Medulla Oblongata, . 236
Concluding view of the Sensitive and Motor System of Nerves, 238

APPENDIX OF CASES.

CASES ILLUSTRATIVE OF THE DISTINCTION IN THE NERVES OF SENSATION AND OF MOTION, ... 244
No. 1. Insensibility of the left upper extremity, the power of motion remaining, . . . 244
2. Similar case, ... 244

No. 3. Loss of Sensibility with power of Motion, . . 244
4. Case of Paralytic Affection, in which Sensation was diminished on one side and Motion on the other, . 245
5. Case of Affection of the Nerves of Sensation as opposed to those of Motion, . . . 247
6. Note of a case of Loss of Motion, Sensation remaining, 247
7. Case of Affection of the Nerves of Sensation, from a severe accident, ... 248
8. Affection of the Nerves of Sensation, . . 248

PARALYTIC AFFECTION OF THE FACE, . . . 248

No. 9. Partial Paralysis of one side of the Face, . . 248
10. John Chapman's case of Paralysis of the Face, . 249
11. Clinical Lecture on Daniel Quick's case of Partial Paralysis of the Face, ... 250
12. Daniel Tooney—Spasm in the Muscles of the Face, 256
13. Proposal to divide the Portio Dura, . . 257
14. Proposal to divide the branches of the Fifth Pair, . 258
15. Division of the Fifth Pair and of the Seventh for Tic Douloureux, ... 259
16. S. Nicholas—Paralysis of the Face, . . 260
17. Mary Unwin—Case of Partial Paralysis, . . 262
18. John Windsor—Affection of the Nerves of the Head, and Paralysis of the Muscles of the Eye, with clinical remarks, ... 264
19. Tumour pressing on the Fifth Pair, . . 275
20. James Godwyn—Disease of the Fifth Pair and of the Nerves within the Orbit; with Paralysis of the Arm and Leg of opposite sides, . . . 276
21. George Bungay—Paralysis of the Muscles within the Orbit, ... 277
22. James Delahay—Partial Paralysis of the Face, . 278
23. Partial Paralysis of the Face from Fracture of the Skull, ... 282
24. Partial Paralysis of the Face from Cold, . . 283

CLINICAL LECTURE ON DISEASES OF THE NERVES OF THE HEAD, . 283

No. 25. Paralysis of the Portio Dura, . . . 289

CLINICAL LECTURE ON DISEASES OF THE FIFTH PAIR, . . 293

No. 26. Mary Ann Webb—Disease of the Fifth Pair, . 293
27. Jane Smith—Paralysis of the Face, . . 301
28. Ann Church—Disease of the Fifth Pair, . . 301
29. Richard Hills—Paralysis of the Face, . . 302
30. Paralysis, with suspicion of formidable disease, . 303
31. Thomas Miller—Partial Paralysis of the Face, . 306

No. 32. Case from Dr Romberg on Paralysis of the Face, . 306
33. Mary Brown—Partial Paralysis, . . 307
34. Affection of the Portio Dura, . . . 308
36. Daniel Stalder—Do. do. . . . 309
36. Do. do. . . . 310
37. ——— Masters, do. . . . 311
38. William Coleman—Paralysis from injury of the Head, 312
39. Paralysis from injury of the Temporal Bone, . 313
40. M. Montault's case of Paralysis of the Face, . 313
41. R. B.—Affection of the Portio Dura, . . 313
42. Similar case, ... 314
43. J. Richardson—Paralysis from Inflammation, . 314
44. Paralysis from Tumour under the Mastoid Process, 315
45. Effect of Paralysis on the Eye—Effect on the growth of Muscles, ... 316
46. Paralysis of one side of the Face, . . 317
47. J. Cooper—Condition of the Face in Paraplegia, . 318
48. Phipp's case—Injury of Portio Dura and Fifth Pair, by a blow, ... 319
49. James Gulland—Affection of Fifth and Seventh Nerves, 321
50. Affection of the Nerves of the Face, . . 323
51. Portio Dura destroyed by Ulceration, . . 324
52. Effect of cutting the Facial Nerve or Portio Dura, . 326
53. Singular affection of Portio Dura on both sides from Syphilis, ... 326
54. Consequences of cutting the Portio Dura in operation, 329
55. M. le Prof. Roux's case of Paralysis of the Face, . 329
56. Thomas Jones—Case of Trismus and paralysis conjoined, ... 320
57. Mr S.—Disease of Portio Dura, extending to the Fifth, 333
58. Dissection of the Portio Dura compressed by a diseased gland, ... 334
59. Affection of the Portio Dura, . . . 335
60. Affection of the Nerves from concussion, . . 336
61. Lord ——— Disease of the 5th Nerve, . . 336
62. Case of division of the Fifth Pair, . . 337
63. Tumour compressing the Mandibulo-Labralis, . 338
64. Similar case, ... 338
65. Contrast from the pressure on the Portio Dura, . 339
66. Case of Partial Paralysis, . . . 339
67. Affection of the Fifth Pair, . . . 339
68. Abstract of a case of disease of the Optic and Fifth Nerve, ... 341
69. Affections of the Muscles of the Jaw, . . 343
70. Martha Symmonds—Disease of the Nerves within the Orbit, ... 343

No. 71. Disease affecting the Fifth Nerve, . . 348
72. Eliza Smith—Affection of the Seventh and Fifth Nerves, 348

OF PAINFUL AFFECTIONS OF THE FACE FROM DISEASE OF THE FIFTH NERVE, ... 350
No. 73. Case of Tic Douloureux, . . . 350
74. Do. do. . . . 350
75. Do. do. from affection of the lingual division of the Fifth, . . . 350
76. Mrs. S.—Painful affection from irritation of the internal branches of the Fifth Pair, . . 351
77. Mrs F.—Case of Tic Douloureux, . . 352
78. Clinical Lecture on Tic Douloureux—Successful treatment—Case of Delafield, . . . 354
79. Successful treatment of Tic, . . . 357
80. Case of Mrs W. successfully treated, . . 357
81. Another case of successful treatment, . . 358
82. Case of severe Tic, . . . 360
83. Case of Tic combined with other symptoms, . 361
84. Case of Tic, ... 361
85. Case of similar pain in the thigh, . . 361
86. Case of Tic, ... 363
87. Case of successful treatment of Tic, . . 363

PAINS OF THE NATURE OF TIC IN OTHER PARTS OF THE FRAME—(See above, No. 85, p. 361) . . . 364
No. 88. Case of pain in the Ankle-joint, . . 364
89. ——— pain in the Thigh, . . . 364
90. ——— pains in the Hip and Thigh, . . 364
91. Case of amputation for neuralgic pain, . . 365
92. ——— pains in the upper extremity, in the Arm and Shoulders, ... 366
93. ——— pain in the Elbow, . . . 366

NERVOUS AFFECTION FROM OVER STRAINING, . . . 366
No. 94. Case of Miss G.—Wrist, Arm, and Neck, . 366
95. Case of young lady—Arm, . . . 367
96. Case of Lady—Arm, Shoulder, Neck, and Breast, . 367
97. Case of pain in the Arm, Elbow, Shoulder, Neck, and Face, from overstrained Wrist, . . 367
98. Severe pain from Hand to the Face from a wound between the Thumb and Fore-finger, . . 367
Note of a case shewing the aptness of the Head and Spine to be affected by injury in other parts, . 368
99. (erroneously marked 91.) Case shewing the extreme sensibility of the Trunk, . . . 369

No. 100. Case of burning pain in the Foot from a hard tumour in the Ham, occasioned by a wound, . . 270

AFFECTIONS OF THE EYE, ... 370

No. 101. Case of Paralysis of the Voluntary Muscles of the Eyeball, ... 370
102. Case of incessant motion of the Eye, . . 371
103. Case of spasmodic motion of the Eye-ball from fracture of the Skull, ... 372
104. Case of tremulous and rotatory motions in the Eye, 372
105. Case of incessant motion of both Eyes, . . 372
106. ——— rolling of the Eyes, . . . 373
107. Case of Cataract on both Eyes, with oscillatory motion of the Eye-balls, . . . 374
108. Case of F. Robbins—Oscillatory motion of the Eye-balls, ... 374
Note—Of the Eye-lids, as indicating different affections of the nerves, ... 375
109. Case of periodical Blindness from a cause not hitherto observed, ... 376
110. Case of Blindness from dropping of the Eye-lid and imperfect motion in the Eye-ball, . . 380
111. Case of inability to close the Eye-lids, . . 382
112. Cases illustrative of the actions of the Levator palpebræ superioris, ... 383
113. Case of Paralysis of Levator palpebræ, and loss of power in the pupil; by Mr A. Shaw, . . 385
114. Case of uncommon affection of the Portio Dura, . 386
115. Case of twitching of the Eye-lid and side of the Face, 386
116. (marked erroneously No. CXVII.) Case of Strabismus, with affection of the Eye-lid, . . . 387
117. Case of Mrs S.—Double Vision, with violent pains in limbs, ... 387
118. Case of W.—Headach and Double Vision, affection of the Abducens, ... 388
119. Case of a young lady—Affection of the Eye, . 388
120. Case of B. H.—Singular affection of the Eye, . 388
121. On Squinting—Cases of Partial Squinting, . 389

AFFECTIONS OF THE TONGUE AND MUSCLES, . . . 390

No. 122. Case of a lady—Affection of the Tongue, . . 390
123. Case of Frederick Hill—Loss of Speech, . . 392
124. Case of a lady with a sensation of a hair across the Tongue, ... 395

No. 125. Case of Affection of the Voice, and sensation of hairs in the Mouth, ... 395
126. ——— similar affection, and sensation as of Wax on the Teeth, ... 395
127. ——— Affection of the Mouth and Tongue, Velum, and Uvula, ... 396
128. Case of Mr L.—Insensibility of the side of the Tongue and Mouth, ... 396
129. Case of extraordinary state of Deglutition, . 396
130. Case of a Child, Deaf and Dumb, and affection of the Tongue, ... 396
131. Paralysis of Childhood—Case of Mrs B.'s child—Blight, with falling of the Jaw and lolling of the Tongue, ... 396
132. Case of a Child—Loss of the use of the Lower Extremities—Unable to cry, . . . 397
133. Case of a Young Lady—Affection of the Jaw, . 397
134. Case of Difficulty of Swallowing, . . 397
135. Case of a Clergyman affected with Impediment in Speech, ... 397
136. Case of a Physician—Affection of Speech commencing in the Diaphragm, ... 397
137. Case of continual Sound in the Ear, . . 398
138. ——— Deafness from Suppuration, . . 398
139. Case of Delusion, ... 398
140. Case of Epileptic Affections, . . . 399
141. Case of Ambiguous Affection—Sense of Nauseous Smell—Delusion, ... 399
142. Case of Sensation of overpowering and offensive Smell, 399

Cases illustrative of the distribution of the Nerves of Respiration and of Volition, ... 399
Cases of Fracture of Vertebræ of the Neck, . . 399
No. 143. Cases of Fracture of Spine, . . . 400
Case of Charles Osborn, . . . 400
6th and 7th Cervical Vertebræ fractured, . . 400
144. Case of James Saunders—Fell against an Iron-railing—Fracture of 5th and 6th Cervical Vertebræ, . 401
145. Case of Fall on the Shoulders—Injury of the Spine—Fracture of Atlas and Dentata, . . 402
146. Case of Fracture of the Margin of the Occipital Hole; instantaneously fatal on turning his head, . 402
147. Case of Bursting of the process of the second Vertebra from the transverse Ligament of the first, . 402

No. 148. Case of Destruction of the transverse Ligament of the Atlas by ulceration, . . . 403
149. Case of Fracture of the Foramen Magnum of the Occipital Bone, ... 403
150. Case of James Palmer—Diseased Vertebræ of the Neck, 404
151. Case of a Lady—Loss of Motion of all the Voluntary Muscles, and every action of the Body except Respiration, ... 407
152. Case of Accident to the lower part of the Spine, and back of the Head and Neck, . . . 408
153. Case of a child breathing after the Brain had been destroyed, ... 410
154. Case of singular Affection in Hemiplegia, . . 411

SPASMODIC TWITCHING OF THE RESPIRATORY MUSCLES,

No. 155. Case of twitching of Nostrils, Eye-lids, and Mouth, 412
156. Instances in Napoleon—Twitching of the right Shoulder, accompanied by twitching of the Mouth, . 412
157. Case of Spasmodic Affection and twitching of the Face, Eye, and angle of the Mouth, . . 413
158. ——— Spasmodic Affection of the Respiratory Nerves and Muscles, ... 413
159. Case of Disordered Action of the Muscles of the Neck, 414
160. Case of Spasmodic Action of the Sterno-cleido Mastoideus producing continual Motion of the Head, . 415
161. ——— Spasmodic contortion of the Head and Neck, 416
162. Case of Affection of the Respiratory Nerves on the side of the Chest, ... 417
163. Case of Spasmodic Action of the Sterno-cleido Mastoideus and Trapezius Muscles, . . 419
164. ——— similar Affection, . . . 420
165. Case of T. Brown—Spasmodic Affection of the Muscles of the Neck and Shoulders, . . . 421
166. Case of Spasmodic Affection of the Neck, . . 422
167. Case of Miss C. 422
168. Case of Wry Neck, ... 423

CLINICAL OBSERVATIONS—

No. 169. Case of Spasmodic Contraction of the Back and Shoulder, ... 424
170. Case of Stoppage of the Involuntary Muscles on Sleep, 425
171. Case of Affection of the Nerves of Respiration, . 426
172. Case of Lady P.—Singular Affection of the Respiratory Nerves, ... 426
173. Case of Constriction of the Chest, and Affection of the Muscles of Respiration, . . . 427

No. 174. Case of Hemiplegia, with peculiar Affection of the Respiratory Nerves, ... 428
175. Case of obstinate Contraction of the Tibialis Anticus, 429
176. Case of Spasmodic Contraction of the Flexor Muscles of the Leg, ... 429
177. Case of powerful Contraction of the Flexors and Tibialis Anticus of both Legs, . . . 429

PARTIAL WASTING OF THE MUSCLES OF THE EXTREMITIES, . 429

No. 178. Case of Wasting of the Muscles of the Thumb, . 430
179. ——— Wasting of the Muscles of the Arm, . 430
180. ——— Wasting of the Muscles of the Thigh, . 431
181. Case of partial Wasting of the Muscles of the Upper extremities, ... 432
182. ——— the same Disease, . . . 434
183. Case of Wasting of a Child's Leg in consequence of an Epidemic Fever in St Helena, . . . 434
184. Case of Affection of the Voluntary Nerves, . 436
185. Spasmodic Action of particular Muscles, . . 436
186. Peculiar Affection of the Muscles, and in the performance of particular acts, . . . 436
187. Loss of Power in the Fingers, . . . 437
188. Case of peculiar Affection of the Voluntary Muscles, 437

ABRIDGED STATEMENT OF THE MORE COMMON VARIETIES OF PARALYSIS, 437

No. 189. Case of partial Paralysis, . . . 438
190. Case of partial Paralysis in the Lower Extremities, with Sensibility of the Skin, . . . 438
191. Case of Shaking of the Arm, . . . 438
192. Case of Singular Affection, with partial Paralysis, . 439
193. Case of partial Paralysis, with singular Affection of the Muscles of the Leg, . . . 439
194. Case of Affection of the Voluntary Muscles, . 439
195. Case of Paralytic Affection of Voluntary Muscles, . 440

PARAPLEGIA, ... 440

REMARKS ON THE VOLUNTARY MUSCLES, . . . 440

No. 196. Case of a Child, ... 440

NOTE, BY A PUPIL, ... 441

INTRODUCTION.

WHEN the nerves of a human body are fully displayed, even after the most minute dissection, there appears to be inextricable confusion. But if the nerves of two or more bodies are dissected, and if we lift a thread or nerve and observe its connexion in one body, we find that the second, and all the other bodies, have a similar thread and similar connexions as in the first. If prosecuting our observations, we trace one, two, or three nerves distributed to one organ in the first body, we find just so many nerves, and in the same order, in the second and in the other bodies. If we pick out a small ganglion in the one, we find a similar ganglion, in the precise same spot, with exactly the same twigs of connexion, in all the other bodies. There are, in all our dissections, displayed the same joinings and branchings of the same number of nerves. At first this intricate net-work seems accidental; neither arrangement nor system is apparent: but when the minute twig discovered by one anatomist in London is as surely found by another at Pavia, as two astronomers, at different spots on the globe, trace in the heavens, with the same certainty, the discoveries of Herschel, there can no longer be a doubt of the nerves being distributed with regularity and system.

The term irregular may be applied, without objection, to arteries and veins, because it is immaterial whether a part of the body be supplied by this or that branch of the aortic system; arterial blood will be supplied to the part whether it comes from one branch or the other. But the seeming irregularities of the nervous system ought not to be considered as truly irregularities. There is no such thing as a nerve deviating or being wanting (an occurrence frequent in the vascular system), without the loss of some essential faculty. If there appear to be any defect or deviation, it can proceed only from some error in our mode of proceeding;—either the dissection has not been minutely prosecuted, or mere contact has been mistaken for a union of the branches of the nerves. It will be shewn that the property diffused through them results altogether from the source from which the nerve is derived, and that one nerve cannot supply the office of another.

From the age of Galen, or perhaps from that of Herophilus and Erasistratus, down to the present time, the hypothesis has been maintained with little variation, that the brain presides over the body through the spinal marrow and the nerves. It was supposed that a fluid was secreted from the brain, and transmitted through the nerves; that these nerves were tubes; and that this fluid was universally distributed to the moving and sensible parts of the frame; and that through its agency all the phenomena of life were carried on. But this notion is utterly at variance with anatomy; for if the brain is the common source of this fluid, where is the necessity for those double and triple sets of nerves which are given to one organ? and where is the utility of those intricate connexions which are formed amongst the nerves? If this supposed nervous fluid were one prevailing kind of influence, and equal to all the phenomena exhibited in the nervous system, we should have expected to find the nerves diverging regularly from the brain to all parts of the body. But this is not the case.

It has been attributed to me that these views are nothing more than those of Galen. I should have been proud had I reconciled the theories of the ancients with the more perfect knowledge of modern anatomists. But it is not so. The division proposed by Galen of nerves arising from the brain into those of sensation and of motion, or into hard and soft nerves, implies no more than that he understood there were nerves appropriated to the organs of the senses, and nerves for the governance of the muscles. Neither does the idea of Galen, that the ganglion was given to a nerve when strong motory powers were required, indicate much knowledge of the distinction to which I have adverted. Galen supposed the same nerve to possess the two properties of motion and sensation, motion being active, and sensation passive; and he thought that there possibly might be nervous power sufficient for sensation, though not for motion. He attempted thus to explain how it happened that sensation remained when motion was lost. And the same idea has been entertained by some more modern authorities.

Vesalius resisted the authority of Galen on many points, but he adopted, with little variation, both his description of the anatomy of the brain and nerves, and his opinions on the nervous system. The vital spirits, according to him, were elaborated in the brain, transmitted from the ventricles of the brain into the spinal marrow and the roots of the nerves, and so scattered over the body.

Willis indeed gave an arrangement of the system, adapted to the appearance presented on dissection, and he entertained many ingenious conjectures on the uses of the parts of the brain; but still that organ was the sole *officina spirituum*, the source of that subtle spirit which was distilled through the nerves. And if Willis be found at any time engaged in an inquiry whether there be a vital and animal spirit, or a sensorial and motor spirit, it is only hypothetically, and is neither founded strictly on anatomy nor on experiment.

All these questions are touched on by Haller, and in the end he concludes—"But I know not a nerve which has sensation without also producing motion; the nerve which gives feeling to the finger is that which moves the muscles; and the fifth nerve of the brain branches to the papillæ of the tongue, and also to the muscles." It is therefore certain that Haller, who had traced the opinions of authors with the utmost diligence, gathered nothing from the ancients. The confusion in his mind, as well as in the minds of our most learned physicians and commentators, declared the necessity of having recourse to the volume of nature itself.

Dr Alexander Monro, in his work on the Nervous System, had noticed most of the points of anatomy to which my inquiries have been directed. He had discovered that the ganglions of the spinal nerves were formed on the posterior roots, and that the anterior roots passed the ganglions. Santorini and Wrisberg had observed the two roots of the fifth pair of nerves; Prochaska and Sœmmerring the resemblance between the spinal nerves and the fifth pair; and they asked, Why should the fifth nerve of the brain, like the nerves of the spine, have an anterior root passing by the ganglion, and entering the third division of the nerve?*

---

* Although the course of my investigations has not been directed by

Notwithstanding this approach to the knowledge of the true anatomy of the nervous system made by these celebrated men, still the efforts of those who followed them were undirected by any principle; and the multiplicity of anatomical facts which the anatomists of Europe continued to discover, instead of increasing the light, only tended to throw obscurity over the subject. Paletta described the anterior root of the fifth nerve, and, by tracing it to the muscles of the jaw, conceived it to be a

---

the suggestions of anatomists, yet it is curious to observe how much importance may be now given to passages which heretofore had little interest attached to them.

Prochaska concludes his essay on the Structure of the Nerves with this remarkable passage:—" Quis rationem dabit: quare nam nervorum funiculi tam in sua crassitie quam in miris suis plexibus ac concatenationibus per totum suum decursum ludant? Quare radices anteriores nervorum spinalium ganglia spinalia insalutata transeant, et quare nam solæ posteriores radices ganglia spinalia trannare cogantur? Et cur radices nervorum spinalium anteriores ramosæ in medullam spinalem inseruntur, aut, si mavis, ex ea medulla oriuntur, dum interim posteriores radices funiculos teretes non ramosos complectuntur? Quare omnium cerebri nervorum solum quintum par post ortum suum, more nervorum spinalium, ganglion semilunare dictum facere debet, sub quo peculiaris funiculorum fasciculus ad tertium quinti paris ramum, maxillarem inferiorem dictum, properat insalutato ganglio semilunari ad similitudinem radicum anteriorum nervorum spinalium? Et plura alia in structura nervorum occurrentia proponi possent, quorum ratio sufficiens reddi nondum potest: attamen utrum unquam reddi poterit, desperandum esse minime videtur, verum liceat interim ea lactari spe, quam tritum proverbium (*dabit dies quod hora negat*) haud raro non vanam fuisse ostendit."—*Prochaska, de Struc. Nerv.* 1779.

Sœmmerring, when discussing what were the probable uses of the ganglions, says, " Quæ causa est cur in radice posteriore tantum nervorum spinalium ganglia inveniuntur, minime autem in priore. An priore nervorum spinæ medullæ radice, et minori quinti nervorum paris portioni novo hoc virium augmento non opus est?"—*Sœmmerring, de Corp. Hum. Fab.* tom. iv.

To shew the deceitfulness of mere experiments, read *Sauvage Nosol. Method.* tom. iv. p. 17, Lupin, 1795. Concluding " *Nulla enim in corpore est fibra nervea quin sentiet.*"

muscular nerve.* And when we should have expected that he was about to discover the truth, he acknowledges that he does not know what to make of the other branches of the fifth nerve.

Among our countrymen a conflict of ideas existed. Johnstone conceived that ganglions were for the purpose of cutting off sensation; while Monro maintained that they did not cut off sensation, because they were attached to nerves which he knew to be muscular nerves! He says, "that ganglia do not serve to render motions independent of our will, as an ingenious author (Johnstone) has supposed, is evident, without observing more than that all the branches of the fifth pair, and the posterior half of all the spinal nerves of the voluntary muscles, pass through ganglia."†

If I had ascertained nothing more than that no motor nerve passes through a ganglion, the observation would have been important towards the true doctrine of the nerves.

Scarpa dwells with great minuteness on the ganglions of the spinal nerves, and the double origins of the nerves. And he asks, "Is the posterior root a proper and peculiar kind of nerve, belonging exclusively to the spinal marrow, whilst the anterior root is a cerebral nerve?" The observation, standing in this shape, carries no force with it, and leaves the system doubly confounded.

No better proof can be afforded of the utter confusion which prevailed, than the explanation of Sœmmerring. His elucidation of the subject is, that many small nerves are equivalent to one larger nerve, and that this is the reason why three nerves are given to the tongue. Monro, in like manner, says, that two nerves are given to the face, lest, by the accidental division of one, the face should be deprived of nervous power altogether. This is the authority on which surgeons were wont to divide the nerves of the face in the attempt to cure tic douloureux. They did so, believing, that if one nerve of the face were cut, the remaining nerve would bestow both sense and motion, though in a diminished degree.*

---

* He saw the branches *crotophiticus* and *buccinatorius*, which he considered to be voluntary nerves, and to be the cause of trismus.

† *Monro's Plates of the Nerves*, page 55.

Bichat was a man of genius. His eloquence, united to an indifference for the authorities in anatomy, overpowered the physiologists of the Continent, and introduced misconceptions as to the relative importance of the parts of the nervous system. He taught at the commencement of the French Revolution, when the entire overthrow of former systems, and the substitution of new theories, were readily and anxiously entertained. He divided the nerves into two distinct systems, instead of the one uniform system of the ancients, according to which the nerves proceeded from the sensorium, as a grand centre, and from that derived their powers. One of his nervous systems had its centre in the brain, and this consisted of nerves destined to receive impressions, and of nerves which conveyed the influence of the will to the muscular system.† The other system had many centres. Its power emanated from the ganglions, which he observed largely scattered among the viscera; and each ganglion was a distinct source of nervous influence, whilst a relation was preserved between them by connecting nerves. The first was the nervous system of the animal life, having one centre in the brain, to which sensation is propagated, and from which motion proceeds; whilst the second system was that of organic life, having many distinct centres, and many functions relating to the operations of the animal economy, over which the mind had no power.

---

* We find Lobstein, Professor of Anatomy at Strasburgh, expressing the same opinion in 1823:—" Nervus præsens deficientis suscipeat munus."

In the same work it is stated, " Sicut in nervis cerebralibus sit voluntatis imperio subjectis, ita in nervo sympathetico principium nervosum it reditque, id est trunco in ramos, et vicissim e ramis in truncum, seu potius celerrimo cursu movetur."—*De Nervo Symp.*

† We find him saying, that one nerve cannot be for sensation and another for motion. " Cette remarque preuve qu'il n'y a pas des cordons nerveux destinés au sentiment, et d'autres au movement, et que, si les memes nerfs ne se servent pas à ce double usage, la difference est dans les filets et non dans les cordons."—*Anat. Gen.* vol. i. 128.

This bold invention was supported by many curious instances, and exhibited much knowledge, as well as ingenuity: but it was anatomically incorrect. Two errors pervaded the whole. The first was, that the nerves of his animal life have ganglions; that thirty-one pairs of large ganglions, in regular order, and carefully protected, like important organs, are formed on the fifth nerve of the brain, and on the nerves of the spine. This should have caused at once the rejection of the name of ganglionic system of nerves, given to his nerves of organic life.* But his error was not merely the misapplication of a name: there was radical error throughout the whole system; and although Bichat's *ganglionic system* was presented with the aspect of novelty, there was, in truth, no actual discovery. Anatomists had already convinced themselves that the sixth nerve was not the root of the sympathetic nerve; that a filament so small could not be the trunk of that system which, expanding into larger branches, and furnished with numerous ganglions, was seen to pervade the whole viscera, and to connect itself with every nerve of the body. The opinion had been propagated that it was a system of nerves extending everywhere, and not depending upon the encephalon.

---

* Yet the term "The Ganglionic System," meaning the net-work of nerves of the viscera, studded with ganglions, is still used by all our domestic authors. Inattention to the difference in the structure of the ganglions on the regular system of nerves of sensation and of the ganglions on the sympathetic nerves, has not only delayed the reception of more correct views of the nervous system, but it still prevents improvement. The ganglions on the spinal nerves, and on the fifth of the head, are of a different texture from those on the visceral or sympathetic system of nerves. This distinction is important in tracing the nerves; for example, the main ganglion (Gasserean) of the fifth is very different from the ganglion on its branches, as, for instance, the lenticular ganglion. These latter are of the same structure with the sympathetic ganglions, and shew the extension of that system to the head.

But the most remarkable misconception of Bichat was in imagining that he saw, in the ganglionic system, or the sympathetic system of man, the development of that series of nerves which is perceived in the lower creatures: thus considering those nerves which give sensation and volition in them, to be the same system which, in the human body, gives no token, even by his own shewing, of being either the organ of sensation or of voluntary motion.

I may here state what is known of the *sympathetic nerve*. When I began study, it was usual to demonstrate this nerve as a nerve of the brain, descending more directly from the sixth and the second division of the fifth nerves—to trace it through the carotid foramen, down the neck with the *nervus vagus*, and so on to its divisions to the heart, and then as *intercostal* and splanchnic to the viscera. This term, intercostal, sufficiently marked its connexions; it pointed out the frequency of its connexions with the intercostal nerves, viz. the spinal nerves which take their course between the ribs.

The sympathetic nerve was so denominated, because, it being acknowledged that nerves were the only bonds by which the sympathies of distant parts were to be accounted for, and a sympathy being observed between different parts of the body, as the emotion of blushing expressed in the face, the affection of the organs of sense, the affection proceeding from the influence of passion on the body, the act of sneezing from tickling the nose,—it was inferred that all these were to be explained by sympathy through this nerve. The experiments detailed in this volume, and the cases in the Appendix, will clear away that mass of error in which physiologists were involved.

But, having shewn how far Bichat was incorrect, I must now state our obligations to him. We owe the important fact to him, that there is no sensibility in the branches of the sympathetic nerve, nor in the ganglions formed in its progress. These parts may be cut and pinched in the living body without producing pain, and, as far as we at present perceive, they move no voluntary muscular apparatus. This was a most important fact.*

The functions of this system are known only by negatives: thus we have ascertained that they have nothing to do with volition, nor with sensation, nor with respiration, nor with expression, nor with speech.

We are left therefore to the conjecture, that the sympathetic nerve, (or the ganglionic system of nerves, according to Bichat), is adapted for those thousand secret operations of a living body which may be called constitutional. Circulation, secretion, and absorption, are operations which sympathetically affect the entire frame. Constitutional peculiarities, fever, and general derangement of health, must, we conceive, belong to this system of nerves. And we call it system: for it is curious to observe, that, by the progress of anatomy, this lesson has become easy. Painfully, and with a stretch of memory, we formerly endeavoured to recollect the relations and connexions of the sympathetic nerve, but now we know that it is extended universally; that its relations to the nerves of the head are not more remarkable (when looked upon free of hypothesis), than its branches to the nerves of the extremities; that it extends to all the internal viscera, and that it is universally distributed to all parts of the body. In this is its peculiarity.

---

* Quant à la sensibilité animale; voici ce que j'ai observé sur ce point. Comme en ouvrant l'abdomen d'un animal, d'un chien par example, il vit tres bien pendant un certain temps, et reste meme calme apres les premiers instans de souffrance, j'ai attendu ce calme qui succede à l'agitation de l'incision des parois abdominales, puis j'ai mis le ganglion semilunair à decouvert, et je l'ai irrité fortement: l'animal ne s'est point agité; tandis que j'ajaçois un nerf cerebral lombaire pour comparaison, il crioit, se soulevait et se debattoit.—BICHAT, *Anat. Gen.* vol. i. p. 227.

We cannot assign a commencement to the sympathetic nerve. It has a twig from each nerve of the spinal marrow; but these twigs are very small nerves, compared with the mass of nervous matter seen in the centre of the viscera of the abdomen.

The semilunar ganglion and the solar plexus being parts of this system, and the branches of nerves extending and diminishing from this region, give countenance to the idea that we have in them the centre of the sympathetic system.

This conjecture is supported by the fact, that the viscera of the abdomen perform functions the most independent of the will, and over which the mind has no control. Indeed it appears to be one of the happiest provisions of Nature, that these functions of vital importance should be withdrawn from the governance of the mind. No part of the human body is altogether independent. When by circuitous influence, the mind does operate on the vital functions, we know what disturbance is produced; which is enough to shew with what beneficial effects the relations are made remote.

If any thing were wanting to prove the great importance of the centre of the sympathetic system, it is this,—that a blow on the stomach is more certainly and immediately fatal than an injury to the brain.

GENERAL VIEW

OF

THE NERVOUS SYSTEM,

INTRODUCTORY TO THE PAPERS DELIVERED TO THE ROYAL SOCIETY.

The Nervous System, as displayed in the following papers, embraces only the brain and nerves of sensation and voluntary motion, and nerves of respiration; leaving out of the inquiry the nerves of the senses and the sympathetic system.

A nerve dissected from the body appears a dense white cord. This density is owing to the membranous coverings, and not to the proper matter of the nerve. These membranes correspond with the coverings of the brain, and indeed may be traced from them. The membrane which is in immediate contact with the matter of the nerve, and which may be traced from the pia mater, is delicate and vascular. It forms the sheaths or tubes in which the matter of the nerve is contained.

When we examine a nerve, we see that it consists of distinct filaments, viz. the soft matter of the nerve surrounded by the membrane. There is nothing in these filaments to distinguish them from each other, or to declare their offices. The subserviency of any one of them to a particular office, must be discovered by following it out, and observing its relations, and especially its origin in the brain or spinal marrow.

Such a nerve as we have alluded to, was supposed to have all its threads alike. It was called a common nerve, as being at once a nerve of sense and of motion. But by these inquiries, it has been proved that each filament or tract of nervous matter has its peculiar endowment, independently of the others which are bound up along with it; and it continues to have the same endowment throughout its whole length. If we select a filament of a nerve (for example, one of those in the compound nerve referred to above), and if its office be to convey sensation, we shall find that that power belongs to it wherever it can be traced: and whether it be in the foot, leg, thigh, spine, or brain, if it be bruised or pricked, or injured in any way, sensation and not motion will result; and the perception arising from the bruise or other impression will be referred to that part of the skin where the remote extremity of the filament is distributed.

As the matter of the nerve is every where the same, and the apparent difference is only in the manner in which the fine cellular membrane forms the envelope, (it being soft where the nerve is protected; hard and cord-like where it is exposed or subject to pressure;) I have been desirous of having some term or terms which might be applicable to the same tract of matter through its different stages, whether traced in one direction or in the other.

Where certain whitish streaks of nervous matter are discoverable in the substance of the brain, we may use the term *Tractus* as being already an anatomical term.

Where, in any part, the line of a nerve is not merely discoverable by its colour, or the direction of its texture, but when it is raised, and exhibits an external convexity in form of a cord, the term *Column* or *Rod* may be used.

Where the nerves emerge in distinct threads, *Funiculi* has seemed to me a proper term; and where these *funiculi* are projected in combination, I use the word *Fascis.* Although we must keep the term *Nerve,* yet it is, as we may say, an abused term. Let us, at all events, distinguish betwixt a simple and a compound nerve.

A Simple Nerve is that in which the threads or funiculi which form its root arise in a line of sequence from the same *Tractus* of the brain or column of the spinal marrow. A Compound Nerve is that in which the threads forming the roots arise in double rows, and each row from a different column or tract of nervous matter. For example, the Ninth Nerve is simple; a Spinal Nerve is compound.

A Nerve, then, is a cord composed of nervous matter and cellular substance. The nervous matter consists of distinct funiculi, and these funiculi are bound together in their course to the point of distribution, although they may possess properties quite dissimilar.

If we were successfully to trace a nervous cord, (we shall suppose from a muscle of the fore-arm), it would be found a simple filament, thread, or funiculus. We should first trace it into a compound nerve, (perhaps the ulnar nerve), which we call compound, because there are in it filaments of motion and filaments of sensation bound together. At the root of the axillary nerve we should trace it into the composition of a *fascis,* where it forms the anterior root of a spinal nerve. Being further traced, it would merge in the anterior column of the spinal marrow: and traced into the base of the brain, it might be followed as a *tractus,* a streak of matter distinguishable from the surrounding substance, until it was seen to disperse and lose itself in the cineritious matter of the cerebrum. In all this extent, however combined or bound up, it constitutes one organ, and ministers to one function, the direction of the activity of a muscle of the hand or finger.

And so, if we trace other funiculi or filaments, whether they be for the purpose of sensation or of motion, each retains its office from one extremity to the other; nor is there any communication between them, or any interchange of powers, further than that a minute filament may be found combined with filaments of a different kind, affording a new property, not to the nerve thus constituted, but to the part which receives both of them in their final distribution.

The error throughout has been in tracing the nerves from the brain, and doing this incorrectly, taking the instance of the human body—the highest and most complicated form—as the foundation of the system, instead of tracing the nerves through the changes they exhibit in different animals, in correspondence with the formation of those animals, or with the organs they possess.

When we know that some creatures low in the chain of existence, move and shrink from injury, and yet possess no nerves, we cannot suppose that such creatures have no nervous matter in their composition. Such a supposition would lead us into the difficulty of being compelled to admit that nature is not uniform—that sensation and motion are in one creature endowments of the nervous system, whilst in another a different source of life and action is in operation. This consideration forces on us the belief that, in creatures which have distinct organs, or which have muscles requiring combination, to the performance of their functions, the nerves are introduced to connect organs which singly, and as insulated parts, are already (in these lower animals) in possession of vital power. That power is possessed through the operation of the same diffused nervous matter in all animals, from the simplest up to man.

When this is ascertained, a material difficulty in our investigation is removed; we obtain a clew to that increasing complication of nerves seen in animals as we ascend in the scale of existence. The lowest condition of the nervous system is found in animals which are not symmetrical in form, and have imperfect organs of motion. In such animals an irregular central ganglion, with an attached nerve, is all that is perceived. But if a creature possess regular organs of progression, requiring an arrangement of many muscles to produce a combined operation, we find an orderly provision of nerves. The foot of the gastropoda has little rough points, which lay hold on a surface; each of these points has its regular muscle, and each muscle has its nerve; so that a central chain, or a cauda equina, of diverging filaments may be seen.*

---

* These ideas, suggested by an examination of the nervous system of the lower classes, correspond with modern arrangement and classification, founded on the nervous system. The *Radiata* of Cuvier is dismembered, because certain animals have no discernible nervous system, and these are called *Acrita*. The remarkable circumstance in these animals is, that although, at some period of their existence, they have sensibility and motion, yet no nervous system is discernible.

The new terms of *Cyclo-neura*, as distinguishing other animals of the radiated class (as the *asterias*, *actinea*, *medusæ*, *echinus*, &c.) is very properly drawn from the form of their nervous system, viz. a circle with filaments diverging.

Again, the term *Cyclo-gangliata* is applied to the ganglionic circle around the intestinal canal of the mollusca.

But the term *diplo-neura*, a long double nerve, we shall find as we proceed to be incorrect.

But if, for example, such an insect as the ***Scarabæus nasicornis***, be dissected before and after its metamorphosis, a singular change in the nervous system will be observed, corresponding with the change in its organs of motion. The ganglions and diverging nerves, appropriate to the numerous muscles of its *foot*, disappear, and the system appropriate to the winged insect takes their place.

What we see in the change of structure in the same insect before and after it takes wing, may be seen more satisfactorily by comparing one animal with another which differs in organization. As new organs of sense are bestowed in the ascending scale of animals, new nerves and new ganglions are given; and the number and magnitude of the nervous cords are increased as new or more perfect organs of motion are bestowed.

Wherever we trace nerves of motion we find that, before entering the muscles, they interchange branches, and form an intricate mass of nerves, or what is termed a *plexus*. The plexus is intricate in proportion to the number of the muscles to be supplied, and the variety of combinations into which the muscles enter. The filaments of nerves which go to the skin regularly diverge to their destination. The nerves on the face, and those on the side of the neck, form plexuses; but the grand plexuses are near the origins of the nerves of the upper and lower extremities. And from the fin of a fish to the arm of a man, the plexus increases in complexity in proportion to the variety or extent of motions to be performed in the extremity.

Muscles are arranged and combined together by connexions, not between themselves, but between the nerves going to them; a *plexus* is that network formed b the interchange of the filaments of nerves before they penetrate to the muscles. It is through the connexions formed in the plexus that some muscles are combined into a class, so that they act, as it were, by one impulse; and it is by the same means that others are arranged as their opponents. All the varieties of combinations are formed in the plexus, and there the curious relations are established which exist between the contraction of one class and the relaxation of the other.

I should here observe, however, that this power attributed to the plexus, is founded on the anatomy purely, and is not confirmed by experiment. It is no essential part of the system which I am laying down.

OF THE CONNECTIONS OF THE NERVES OF SENSATION AND OF VOLUNTARY MOTION WITH THE SPINAL MARROW, AND OF THE RELATION BETWEEN THE SPINAL MARROW AND THE CEREBRUM.

In a subsequent part the question is discussed, Whether the spinal marrow consists of mere columns of communication, intermediate between the nerves and brain, or whether it be at the same time a source of energy in itself; at present we waive that question, and mean to trace the relation of the nerves through it to the brain.

But it has not been adverted to, that the spinal marrow is an organ of respiration, where those relations are established, on which the whole motions entering into the act of respiration depend. Yet for this triple function the spinal marrow is constructed; and this is the real distinction between it and the central cord (diplo-neura) of the animals lower in their classification. It is in fact the cause of that peculiarity in the bony structure of the higher animals, which has given them the name of *Vertebrata*.

The spinal marrow is peculiar to the vertebral animals. Superficial observers may be satisfied by saying, that it must be so, because the spine is necessary to conceal and protect the marrow: But there is much more than this in the established relationship. The spine formed by vertebræ is necessary to such a constitution of the thorax as shall render the thorax capable of the motion of respiration; and the spinal marrow is necessary to that form and distribution of the nervous system which is required for associating and combining the muscles of respiration. Without the machinery of the spine and ribs and muscles, the thorax and abdomen could not rise and fall in respiration; and unless the spinal marrow possessed this *new* property, through this *new* column, with the corresponding arrangement of nerves, the motions of the trunk could not be combined in respiration. Thus the spinal marrow, the spine and ribs, and the muscles of respiration, are essential to each other: they constitute the several parts of a grand design subservient to respiration.

In animals which do not breathe by an uniform and general motion of their bodies, there is no spinal marrow. There is only a long compound and ganglionic nerve, extending through the body, for the purpose of sensation and motion. This cord does not actuate their animal machine with alternate dilatation and contraction. There may be a motion of some part which admits and expels air from a cavity, or agitates the water, and is subservient to oxygenation of the blood; and there may be a nerve supplied to that apparatus, with sensibility and power suited to the function thus to be performed, and resembling the par vagum of the human body in office. But there is no regular and corresponding distribution of a respiratory system of nerves to both sides of the body, nor any arrangement of bones and muscles, for a general and regular motion of the frame, like that which takes place in vertebral animals, and which is necessary to their mode of existence.

In animals having a simple line of nerves with ganglions, as in the earth-worm, the anterior ganglions, (although they are the smaller ones,) have a control over the rest of the body. If such a creature be divided, the anterior part will preserve its concatenated motion, and move away; the posterior half will remain writhing, as if suffering, its motions want aim, and it remains in the same spot. Cold-blooded animals will live without the brain. Birds whose heads were cut off, Le Gallois says, walked, seemed to feel pain, and moved their feet towards the part. Flourens goes further, for he says that a bird, deprived of the cerebral lobes, dressed its feathers, and ran and leaped.

Although I trust very little to these observations, it must be conceded that in the lower creatures the brain does not possess all that influence, either on the movements of the frame, or on the life itself, that it does in man and in the higher animals; and that it becomes more and more important in proportion as the animals rise in the scale of intelligence.

The question must therefore be asked, How far does the spinal marrow retain the offices of the ganglionic system of the Vermes for example? how far is it independent of the brain? and what is the mode and the degree of relation between the brain and spinal marrow? Such appears to me to be the course of study which is to improve the knowledge of the nervous system. Experimenters have gone much too far into subjects of extreme delicacy, and to the discussion of which their knowledge is not competent, until these leading questions be satisfactorily answered.

When we trace the nerves into the spinal marrow, we observe that they split; and when the *fasciculi* separate like the strands of a rope, they are no longer entangled, but run a straight course to the spinal marrow. That fasciculus which goes off towards the posterior part of the spinal marrow forms a ganglion before it finally disperses. That fasciculus which disperses to the anterior column of the spinal marrow has no ganglion on it.

We trace the anterior fasciculi into the anterior column of the spinal marrow very distinctly. On an accurate preparation of the spinal marrow we can trace, without the suspicion of an error, the anterior column of the spinal marrow upwards into the cerebrum: First, into the anterior *corpus pyramidale*; next through the *pons Varolii*: then forming the anterior part of the *crus cerebri* (anterior to the corpus nigrum): and, finally, into the cerebrum.

The posterior fasciculi of the spinal nerves I can now trace with equal precision into the middle column of the spinal marrow. This middle column I now prove to be the exact counterpart of the anterior column. I trace it up into the posterior corpus pyramidale, that which lies in the fourth ventricle, forming with its fellow the calamus scriptorius. It goes then under the *valvula cerebri*, having formed the posterior part of the pons Varolii, enters into the crus cerebri behind the *corpus nigrum*, joins with the anterior *tractus*, but without mixing with it; and these together disperse, diverging fan-like into the cineritious matter of the cerebrum: the *corpus striatum* and the *thalamus nervi optici* receiving their fibres.

and giving them out to the great mass of the cerebrum.

There is thus established a relation between all parts having sensibility and possessed of volition, and the great volume of the anterior brain or cerebrum.

This view is simple, but, at the same time so new and important, that we may follow the manner of the celebrated Ruysch, who, confident in his correctness, said to his correspondents, Go to the subject and satisfy yourself.

I have already observed that the first conception which I entertained of the arrangement of the nerves arose from a comparison of those which take their origin from the brain with those which arise from the spinal marrow. The perfect regularity of the latter, contrasted with the very great irregularity of the former, naturally led to an inquiry into the cause of this difference. I said, If the endowment of a nerve depend on the relation of its roots to the columns of the spinal marrow and base of the brain, then must the observation of their roots indicate to us their true distinctions and their different uses.

The spinal nerves are perfectly regular in origin and distribution; being thirty on each side.* Each nerve has two distinct series of roots coming out in packets or fasces, one from the middle column, and one from the anterior column, of the spinal marrow.

I observed that the posterior fascis is formed of funiculi (see the plates), which come out with remarkable abruptness from the column; and their roots form a very regular row or series along the sides of the spinal marrow. They seem at once to burst out from the confinement of the arachnoid coat. These funiculi, converging towards the foramen of the sheath of the spinal marrow, and being collected together, form a ganglion. This ganglion is not seen within the sheath of the spinal marrow; its seat is in the part where the fascis is surrounded and united to the sheath, and just before this root of the nerves joins the anterior one to constitute a spinal nerve.

---

* The tenth nerve of the head, as enumerated by Willis, and called Suboccipital, from its situation, is in constitution a spinal nerve, *i. e.* it has a double root and a ganglion on its posterior root. In its distribution it is similar to that of the spinal nerves, and quite unlike that of the nerves of the encephalon, with the exception of the fifth.

The funiculi of the anterior roots of these nerves gather their minute origins with more irregularity than the posterior; and from a wider surface.

The thirty nerves thus formed of two distinct fasciculi, are suited to perform all the common offices of the trunk and limbs. Is it, then, I inquired, by that combination of properties which they acquire through their double roots, that they are capable of performing their offices? And is this the cause of the simplicity of their arrangement in their course through the body, as contrasted with the nerves of the head? Again, what cerebral nerves, in their distribution to the head and face, correspond in office with the spinal nerves? On the solution of these questions will depend our knowledge of the whole nervous system.

It was necessary to know, in the first place, whether the phenomena exhibited on injuring the separate roots of the spinal nerves corresponded with what was suggested by their anatomy. After refraining long, on account of the unpleasant nature of the operation, I at last opened the spinal canal of a rabbit, and cut the posterior roots of the nerves of the lower extremity; the creature still crawled, and there was no convulsion of the muscles of the back; but on touching the anterior fasciculus with the point of the knife, the muscles of the back were immediately convulsed. But I was deterred from repeating the experiment by the protracted cruelty of the dissection. I reflected, that an experiment would be satisfactory if done on an animal recently knocked down and insensible; that whilst I experimented on a living animal, there might be a trembling or action excited in the muscles by touching a sensitive nerve, which motion it would be difficult to distinguish from that produced more immediately through the influence of the motor nerves. A rabbit was struck behind the ear, so as to deprive it of sensibility by the concussion, and I then exposed the spinal marrow. On irritating the posterior roots of the nerve, I could perceive no motion consequent in any part of the muscular frame; but on irritating the anterior roots of the nerve, there was, at each touch of the forceps, a corresponding motion of the muscles to which the nerve was distributed. Every touch of the probe, or needle, on the threads of this root, was attended with a muscular motion as distinct as the motion produced by touching the keys of a harpsichord. These experiments satisfied me that the different roots, and different columns from which those roots arose, were appropriated to distinct offices, and that the notions derived from anatomy were correct.

The anterior roots of the spinal nerves, and the anterior column of the spinal marrow, being thus shewn to have a power over the muscular system, the next step of the inquiry was distinctly indicated. If I pursue the track of the anterior column of the spinal marrow up into the brain, shall I find the nerves which arise from it to be muscular nerves? An anatomist will at once answer, that only muscular nerves arise in this line.

Pursuing this method, we see the anterior root of the spinal nerve arising from this column. We trace the column up into the corpus pyramidale; and find there the origin of the ninth nerve. We see that this nerve has only one series of roots, corresponding with the anterior roots of the spinal nerves; and that these roots come from the *tractus motorius:* And we cannot forget that this nerve is entirely devoted to the muscles of the tongue; that it is the motor of the tongue; and has nothing to do with the sensibility of that organ.

Following up the corpus pyramidale, we find issuing from it the sixth nerve; a muscular nerve of the eye. Still following up the *tractus motorius* through the *pons Varolii,* we come to the roots of the third nerve, the motor nerve of the eye. *Thus all the nerves arising in this line from the Crus Cerebri to the Cauda Equina are muscular nerves.*

On finding this confirmation of the opinion that the anterior column of the spinal marrow and the anterior roots of the spinal nerves were for motion, the inference presented itself that the posterior column and posterior roots were for sensibility. But here a difficulty arose. An opinion prevailed that ganglions were intended to cut off sensation; and every one of those nerves, which I supposed were the instruments of sensation, have ganglions on their roots.

Some very decided experiment was necessary to overturn this dogma. I selected two nerves of the encephalon; the fifth, which had a ganglion, and the seventh, which had no ganglion. On cutting across the nerve of the fifth pair on the face of an ass, it was found that the sensibility of the parts to which it was distributed was entirely destroyed. On cutting across the nerve of the seventh pair on the side of the face of an ass, the sensibility was not in the slightest degree diminished.

By pursuing the inquiry, I found that the sole organ of sensation in the head and face is a ganglionic nerve. Ganglions were therefore no hinderance to sensation, but, on the contrary, the necessary accompaniment to a nerve of sensibility: and thus my opinion was confirmed, that the ganglionic roots of the spinal nerves were the fasces or funiculi for sensation.

It now became obvious why the third, sixth, and ninth nerves of the encephalon were single nerves in their roots, as contrasted with the spinal nerves; for if the fifth nerve bestowed sensibility universally on the head and face, and all the parts contained, there was no necessity, so to speak, for the third, sixth, and ninth, having the posterior or ganglionic root.

Pursuing the inquiry, and still directed by the anatomy, the next point to be ascertained was, How far the fifth nerve of the encephalon corresponded with the spinal nerves? I discovered that the fifth nerve bestowed sensibility on all the cavities and surfaces of the head and face. I also observed, that where the sensibility of the integuments remained after the division of the fifth nerve, it was only to that extent of surface which was supplied by the nerves of the spine. Where certain fibrils of the spinal nerves extended upon the integuments of the side of the jaw, they were equivalent in office to those of the fifth nerve. In short, in their property of bestowing sensibility, the fifth and the spinal nerves were identified.

But is the fifth nerve in other essential circumstances similar to the spinal nerves? On recurring to the anatomy, and comparing the fifth nerve of the encephalon with a spinal nerve, the resemblance, both in man and brutes, was very remarkable. In the plates of this nerve we recognise corresponding parts in the spinal nerve and in the fifth nerve. In both nerves we see the double roots; the anterior root passing the ganglion, and the posterior root falling into it or forming it.* The most interesting piece of anatomy is to follow back the sensitive root of the fifth nerve; when we find it to be derived from the same track of the spinal marrow with the sensitive roots of the spinal nerves.

Observing that there was a portion of the fifth nerve which did not enter the ganglion of that nerve, and being assured of this fact by the concurring testimony of anatomists, I conceived that the fifth nerve was in fact the uppermost nerve of the spine; or to speak more correctly, the most anterior of the double nerves common to man and animals, of those nerves which order the voluntary motions, and which at the same time bestow sensibility, in its extended sense, on the frame of the body.

This opinion was confirmed by experiment. The nerve of the fifth pair was exposed at its root, in an ass, the moment the animal was killed; and on irritating the nerve, the muscles of the jaw acted, and the jaw closed with a snap.† On dividing the root of the nerve in a living animal, the jaw fell relaxed. Thus its functions were no longer matter of doubt: it was proved to be at once a muscular nerve and a nerve of sensibility. And thus the opinion was confirmed, that the fifth nerve is to the head what the spinal nerves are to the other parts of the body, in respect to sensation and volition.

---

* It is curious to observe the uses which were ascribed to this grand ganglion. Vieussens supposed that it strengthened the nerve; others that it was the bond of sympathy and the source of expression in the countenance: "Et affectuum animi indicia in faciei partibus depingere adjuvet."—*Hirsch.* Sandifort Thes. Dissert. p. 491.

† The experiment was made by the late Mr John Shaw. Mr Alexander Shaw's fingers were crushed by the closing of the teeth.

But here a very important circumstance must be noticed. The origin of the fifth nerve receives no roots from the column of the spinal marrow which orders the action of respiration; and its motor root is distributed exclusively to the muscles of the jaws. How, then, are the features to be moved in sympathy with the lungs, and with the respiratory actions of the breast, neck, and throat? We shall find presently that this is effected through the portio dura of the seventh, and that this is the reason of the very distinct origin and different course of the two nerves.

These facts and experiments have been followed up by others to the satisfaction of all Europe. The opinion has been confirmed that the anterior roots of the spinal nerves bestow the power of muscular motion; and the posterior roots sensibility. When the anterior roots of the nerves of the leg are cut in experiment, the animal loses all power over the leg, although the limb still continues sensible. But if, on the other hand, the posterior roots be cut, the power of motion continues, although the sensibility is destroyed.*

---

* Professor Tiedemann informed me that he had successfully repeated these experiments on the spinal nerves. Similar experiments were made by Professor Müller of Bonn, to controvert the statements made by M. Magendie that both the roots were endowed with motion and sensibility conjointly. He experimented on the spinal nerves of frogs. It appears that, in frogs, the spinal canal can be opened, and the nerves exposed with little disturbance.—*See Annales des Sciences Medicales.*

UNION OF THE COLUMN OF SENSATION AND OF MOTION IN THE MEDULLA OBLONGATA.

THERE may appear to be some incongruity in the announcement of the fact, that an injury of one side of the cerebrum produces a defect of sense and motion in the other side of the body. Nevertheless the paralysis of the side opposite to that injured has been observed from the earliest times: and yet it is not easy to account for this. The mere decussation will not account for it; if by decussation it is meant that the nerves actually pass from the one side to the other. That can produce no such effect; and I am induced to believe that what is called a decussation is in fact a plexus,—a reunion and dispersion, by which the sides of the body are united and drawn into sympathy by their nerves.

At all events, this decussation does not pervade the whole spinal marrow, but only the columns of motion and of sensation. The union of the anterior pyramidal bodies has been long known, and can be easily detected. The demonstration of the union of the posterior column is equally easy, if set about in a scientific manner. This union takes place as the posterior columns ascend towards the fourth ventricle, at the exact level of the corresponding decussation of the anterior columns.

These facts being ascertained, we can hardly suppress our surprise that pathologists should have remained satisfied with the state of anatomy as applicable to their daily pursuits. They saw the effect of injury of one side of the cerebrum in causing the loss both of sensation and of motion in the opposite side of the body, and yet conceived that this was explained by the decussation of the anterior corpora pyramidalia.

WHY THE NERVES WERE AT FIRST DIVIDED INTO REGULAR AND IRREGULAR NERVES.

SOON after I began to teach in the School in Windmill Street, I had made for the lecture of the following day a careful dissection of the nerves under the jaw, on the side of the neck, and the side of the chest. This dissection, as every anatomist knows, presents an extraordinary confusion of nerves. That evening I had occasion to go into the country, and, with my mind still full of the subject, I laboured to reconcile this apparent confusion with the principle which I had laid down, by observing the roots of the spinal nerves, and the distribution of the fifth to the head.

I began by laying down on one sheet of paper the nerves of double origin going out directly from their places, and distributed equally to the corresponding divisions or regions of the body. There appeared not the slightest irregularity; each nerve had its double root; each had its ganglion on one of its roots; each nerve of the spine went out from between the vertebræ in regular succession, and the fifth cerebral nerve supplied the muscles of the jaws, the organ of taste, and the surface of the head. So that the sheet of paper was covered with a perfectly symmetrical system of nerves—the nerves of sensation and motion of the trunk and extremities; and of sensation, taste, and mastication, in the head.

I next set myself to design the irregular nerves, and on drawing the portio dura, the glosso-pharyngeal nerve, the par vagum, the spinal accessory, the phrenic and external respiratory, I found that I had removed what had produced the seeming intricacy in the demonstration. And the very natural reflection and question rose in my mind, In what do the roots of those nerves correspond? It was impossible to miss the fact, that the chief of these irregular nerves came from a distinct column of the spinal marrow in regular sequence; and farther, it was evident that they went to parts already furnished with nerves possessing the two properties of sensation and motion. A system of nerves of great extent, and diverging to all the parts acting together in the office of respiration, was then before me, less symmetrical than the others, but still systematic.

A few experiments of my own, joined with recorded facts, soon evinced that those more irregularly diverging nerves combined the nostril, throat, uvula and velum, larynx, diaphragm, and external muscles of respiration, in one simultaneous effort. By cutting the portio dura, the nostril became stationary: by cutting the pharyngeal, the velum was relaxed: by dividing the laryngeal, the chink of the glottis ceased to play in inspiration: by cutting the phrenic, the diaphragm stopped: by cutting the spinal accessory, the mastoid ceased to heave the shoulder. Lastly, on injuring the side of the medulla oblongata, from which these nerves were derived, the whole act of respiration ceased, and the animal expired.

Such was the origin of the class plans long used in Windmill Street, in the London University, and in the Middlesex Hospital; and such were the early reasonings and observations which led to the distinction of regular and irregular nerves, or to those of volition and sensation, and those for regulating the lungs and the action of respiration.

ON THE NERVES;

GIVING

A VIEW OF THEIR STRUCTURE AND ARRANGEMENT, WITH AN ACCOUNT OF SOME EXPERIMENTS ILLUSTRATIVE OF THEIR FUNCTIONS.

From the Philosophical Transactions, 1821 *; with some additional Explanations.*

DURING the general advancement of science which has lately taken place in this country, observations have been gradually accumulating in the school of Windmill-street, which prove that this department of anatomy has not been stationary.* The nervous system, hitherto the most unsatisfactory part of the studies of the physiologist, has assumed a new character. The intricacies of that system have been unravelled, and the peculiar structure and functions of the individual nerves ascertained; so that the absolute confusion in which this subject was involved has disappeared, and the natural and simple order has been discovered.

---

* This paper was read before the Royal Society on the 12th of July 1821. About this time Sir Humphrey Davy was delighting all scientific men with his discoveries. When in their society, it was often remarked to me, "In your department we can hope for nothing new. After so many eminent men in a succession of ages have laboured on your subject, no further discovery can be expected." This shewed great ignorance of anatomy, since it is a department where every improvement points to something new, and the higher we go, the more is the field of view extended.

In proceeding to give some account of these new observations, the author of this paper had conceived, that it would be more suitable to the scientific body he had to address, to lay the subject before them in the precise manner in which it first presented itself to his inquiries, and to detail his observations and experiments in the order of succession in which they were made; but he has been persuaded by some of the members of this Society[*] to change that form, and to present the subject in the manner to which he has been accustomed in teaching these doctrines: they were pleased to say, that in this way a new subject would be more readily comprehended.[†]

INTRICACY OF THE NERVOUS SYSTEM.

Anatomists have of late, not only in this country, but also in Germany and Italy, made great improvement in the minute dissection and display of the nerves; but whilst the doctrines hitherto received prevail, the discovery of new branches of nerves, and new ganglions, only involve the subject in deeper obscurity. Whilst the nerves are supposed to proceed from one great centre, to have the same structure and functions, to be all sensible, and all of them to convey what has been vaguely called nervous power, these discoveries of new nerves and ganglions are worse than useless; they increase the intricacy, and repel inquiry. The endless confusion of the subject induces the physician, instead of taking the nervous system as the secure ground of his practice, to dismiss it from his course of study, as a subject presenting too great irregularity for legitimate investigation.

---

[*] Captain Kater and Dr Thomas Young.

[†] I believed that attention could not be raised to this great subject by the account of a system founded on anatomy, and on the minute distinctions in the origins of the nerves. It required the announcement of some distinct and remarkable facts, such as this paper contains, to excite inquiry.

When the physiologist sees two distinct nerves, spreading their branches to every part of the face (as in the plate of these nerves), three nerves given to the tongue from different sources, four to the throat, and nerves in most perplexing variety to the neck; when he finds one nerve with numerous ganglions or knots upon it, and another without them; when, in short, after a minute dissection of the nervous system, he finds a mesh, or network, spreading everywhere; it is not surprising that the seeming intricacy and confusion should make him, in despair, resign inquiry. But the author being forced, in the course of his duty, to go minutely, year after year, over the demonstration of the nerves, without allowing himself to resign the subject merely on account of its intricacy, and finding the facts which he had to explain in his demonstrations of the anatomy quite inconsistent with the received opinions, has gradually, after much study, been enabled to decipher and to read that language, of which the character had hitherto been imperfectly known. And now even the youngest students are brought to comprehend so much of the subject, that the idea of chance, or accident, or confusion among these numerous branches, is entirely dismissed; and that which remains unexplained has, by the success of our past inquiries, become a subject of peculiar interest, from the conviction, that attention to the minute anatomy, under the guidance of cautious and fair induction, will, sooner or later, lead to a disclosure of the whole system.

STATEMENT OF THE OBJECT OF THE PAPER.

The author means to limit his inquiry to *the nerves of respiration.*[*] But according to his conception of this matter, these nerves form a system of great extent, comprehending *all the nerves which serve to combine the muscles employed in the act of breathing and speaking.*

The first point of inquiry naturally is, how many of the muscles are combined in the act of respiration? and the second question is, by what means are those muscles, which are seated apart from each other, and many of them capable of performing distinct offices, combined together in respiration? It may sound oddly to speak of the respiratory nerve of the face, of the neck, and of the shoulder; and it may be necessary to give an illustration of the sense in which the term is intended to be employed.[†] When a post-horse has run his stage, and the circulation is hurried and the respiration excited, what is his condition? Does he breathe with his ribs only; with the muscles which raise and depress the chest? No. The flanks are in violent action; the neck as well as the chest are in powerful excitement; the nostrils as well as the throat keep time with the motion of the chest. So if a

[*] I might have said—to shew how the nerves dedicated to the act of respiration tend to produce the apparent intricacy in the distribution of the nerves.

[†] Amongst the first to whom, out of the class-room, the author shewed his plans and explained his views, were the late Dr Thomas Young and Captain Kater. The former of these gentlemen quite lost patience when he heard of the "respiratory nerves" of the face. He had never reflected on the subject of respiration but as a chemical process, and the idea of respiration in the face seemed to him excessively absurd. So long it is before even liberal and scientific men can change their mode of thinking on a familiar subject, or learn to present it to themselves in a new aspect.

man be excited by exercise or passion, or by whatever may accelerate the pulse, the respiratory action is extended and increased; instead of the gentle and scarcely perceptible motion of the chest, as in common breathing, the shoulders are raised at each inspiration, the muscles of the throat and neck are violently drawn, and the lips and nostrils move in time with the general action; if he does not breathe through the mouth, the nostrils expand, and fall in time with the rising and falling of the chest; and that apparatus of cartilages and muscles of the nose (which are as curious as the mechanism of the chest, and are for expanding these air tubes), are as regularly in action as the levator and depressor muscles of the ribs.

It is quite obvious, that some hundred muscles thus employed in the act of breathing, or in the common actions of coughing, sneezing, speaking, and singing, cannot be associated in action without cords of connexion or affinity, which combine them in the performance of these motions. The nerves which serve this purpose, I call respiratory nerves.

THE NERVES OF THE ANIMAL FRAME ARE COMPLEX, IN PROPORTION TO THE VARIETY OF FUNCTIONS WHICH THE PARTS HAVE TO MAINTAIN.

When we carefully examine the nerves of the human body, and compare them with the nerves of other animals, a very singular coincidence is observed between the number of organs, the compound nature of their functions, and the number of nerves which are transmitted to them. If an organ possess only one property or endowment, however exquisite the sense or action may be, it has no more than one nerve; but if two nerves, coming from different sources, are directed to one part, this is a sign that a double function is performed by it. If a part, or organ, have many distinct nerves, we may be certain that, instead of having a mere accumulation of nervous power, it possesses distinct powers, or enters into different combinations, in proportion to the number of its nerves. The knowledge of this circumstance gives new interest to the investigation of this part of anatomy.

Thus, in reviewing the comparative anatomy of the nerves of the mouth, we shall find, that in creatures which do not breathe, the mouth having only one function to perform, one nerve is sufficient. In certain animals, where the face and nostrils have no complexity of relations, these parts have only a single nerve.* If the throat had no complexity of organization, it would have no variety of nerves. But on the other hand, when the anatomist employs weeks to dissect and disentangle the nerves of the tongue, throat, and palate, in the human subject, he finds at length, that he has exhibited the branches of five different trunks of nerves; and there is no clew to the labyrinth, until he considers the multiplied offices of the mouth in man; that it is a pneumatic as much as a manducatory organ; that it is the organ of the voice, and of speech, of taste, and of exquisite feeling. It would, indeed, be matter of surprise, if the same nerve which served for the action of gnawing and feeding in the lower animals of simple structure, should also serve for the governance of those complicated operations, which interpret the wants and sentiments of man.

Such are the views which naturally arise, from an acquaintance with the nerves of the human body; but a comparison of them, with those of the lower classes of animals, enables us to establish a more lucid order; and that not in an arbitrary manner, but perfectly according to nature.

---

* So early had the author announced the opinion which has directed all the improvements in this part of anatomy.

THE NERVES MAY BE DIVIDED INTO TWO PARTS, OR SYSTEMS; THE ONE SIMPLE AND UNIFORM, THE OTHER IRREGULAR AND COMPLEX, IN PROPORTION TO THE COMPLEXITY OF ORGANIZATION.

When the nerves of the face, mouth, throat, and neck of the human subject are minutely displayed, it seems impracticable to reduce the numerous nerves which cross and entwine with each other to two distinct classes; yet nothing is more certain than that this may be done, and according to an easy and natural method.

The principle which is to guide us, is obtained by ascertaining what parts of the organization of an animal are necessary to life and motion; what organs are superadded as the animal advances in the scale of existence, and are necessary to higher and more complex enjoyments and actions.

Where an animal is endowed with mere sensation and power of locomotion; where there is no central organ of circulation, and no organ of respiration but what is generally diffused over the frame; the nerves are extremely simple. They consist of two cords running in the length of the body, with branches going off laterally to the several divisions of the frame. There is here no intricacy; no double supply of nerves: But each portion of the frame has an equal supply, and the central line of connexion is sufficient to combine the actions of the muscles, and to give them the concatenation necessary to locomotion.*

---

* I allude here to the animals classed under the term *Diplo-neura*, and this is the place to acknowledge the merit of Mr Newport (Phil. Trans.)

In the human body there is the same uniform and symmetrical system of nerves as in the leech or worm; although it is obscured by a variety of superadded nerves. These superadded nerves belong to organs, which, in tracing the orders of animals upwards, are observed to accumulate gradually until we arrive at the complication of the human frame. These nerves, additional and superadded to the original system, do not destroy, but only obscure that system; and, accordingly, when we separate certain nerves, the original simple system is presented, even in the human body.

The nerves of the spine, the tenth or sub-occipital nerve, and the fifth or trigeminus of the system of Willis, constitute this original and symmetrical system.* All these

---

I said to him that I had been long convinced that these cords were not single, but that they more nearly resembled the columns of the spinal marrow. I recommended to him the lobster as a subject of investigation, and in a few days he brought me the preparation, exhibiting not two cords, but four; that is, two on each side, other two very distinct in their structure.

* The following is from a paper by the late Mr John Shaw. To those who have interested themselves in these discoveries, during their progress, I need not say how much I was obliged to him, and with what ability he advocated my opinions. Often when I have felt satisfied with ascertaining the facts, he has excited me to further inquiry, and induced me to shape them for the public:—

"*Comparison between the Fifth and Spinal Nerves.*

"1. That the head and face having many parts in every respect similar to the neck, trunk, and limbs, must have corresponding nerves.

"2. That the manner in which the spinal nerves and the fifth arise by double origins, is very similar.

"3. That the ganglion on the root of the fifth nerve, has a strict resemblance to the ganglions at the origin of the spinal nerves.

"4. That the manner in which the branches of the fifth are distributed, and those of the spinal nerves, is the same.

"And, lastly, with reference to the anatomy, we find that the same kind of connexion exists between the fifth and the sympathetic, as be-nerves agree in these essential circumstances: They have all double origins; they have all ganglions on one of their roots; they go out laterally to certain divisions of the body; they do not interfere to unite the divisions of the frame; they are all muscular nerves, ordering the voluntary motions of the frame; they are all exquisitely sensible, and the source of the common sensibility of the surfaces of the body; when accurately represented on paper, they are seen to pervade every part; no part is

tween the latter and the spinal nerves. In their morbid affections, the similarity also holds good: thus, in the common cases of hemiplegia, the spinal nerves and the branches of the fifth are similarly affected. In this disease, the voluntary power over the limbs, and the sensibility of the side affected, are generally destroyed; while in some cases the voluntary power is lost, and the sensibility continues unimpaired, or *vice versa*. This variety also occurs on the face; for there will be all the marks of paralysis in the muscles of the jaw, while the sensibility of the skin and the sense of taste continue entire.

"In experiments on the nerves of the spine and on the fifth, we meet with the same results. If, as in the operation, which is now frequently performed on the nerves of the horse's foot, we cut a spinal nerve after the branches are given off to the muscles moving the part, we shall destroy only the sensibility of that part; but, if we cut the nerve nearer to the brain, we shall not only destroy the sensibility, but also the power of motion. The same happens in experiments on the fifth; for, if we cut a branch which is distributed principally to the skin of the lips, we shall destroy the sensibility of the part, but impair the power of mastication only in a slight degree; but if we divide the nerve further back, then we shall not only destroy the sensibility of the skin, as in the first experiment, but also cut off the power by which the jaws are moved. I cut a branch of the fifth upon the face; the sensibility of the corresponding side of the lip was destroyed, but little paralysis ensued. I cut the nerve nearer the brain, and at a point previous to its having given off the branches to the muscles; then the jaw fell, and the muscles of that side were powerless. I varied the experiment, by irritating the nerve where it lies in the spheno-palatine fissure, immediately after an animal was killed; the jaws then came together with much force, indeed, so as to nip my assistant's finger severely. This last experiment may be compared with the very common use of galvanizing the nerves which pass from the spinal marrow, to supply the muscles of the extremities."

without them; and yet they are symmetrical and simple as the nerves of the lower animals. See Plate I.

If the nerves be exposed in a living animal, those of this original class exhibit the highest degree of sensibility; while, on the contrary, nerves not of this original class or system are comparatively so little sensible, as to be immediately distinguished; in so much that the quiescence of the animal suggests a doubt, whether they be sensible in any degree whatever. If the *fifth nerve, and the portio dura of the seventh,* be both exposed on the face of a living animal, there will not remain the slightest doubt in the mind of the experimenter which of these nerves bestows sensibility.* If the nerve of this original class be divided, the skin and common substance are deprived of sensibility; but if a nerve not of this class be divided, it in no measure deprives the parts of their sensibility to external impression.†

MORE PARTICULARLY OF THE RESPIRATORY NERVES.

The nerves which connect the internal organs of respiration with the sensibilities of remote parts, and with the respiratory muscles, are distinguished from those of which we have been speaking by many circumstances. They do not arise by double roots; they have no ganglions on their origins; they come off from the *medulla oblongata* and the upper part of the spinal marrow; and from this origin, they diverge to those several remote parts of the frame, which are combined in the motion of respiration. These are the nerves which give the appearance of confusion to the dissection, because they cross the others, and go to parts already plentifully supplied from the other system.

---

* Whatever signs of pain may be evinced on touching the *portio dura*, are to be explained by branches of the fifth pair joining the *portio dura* before it emerges from the parotid gland.

† Abundant cases in the Appendix sustain the statement.

The following are the nerves to be enumerated as *respiratory nerves*, according to their functions.

1. *Par vagum*, the eighth of Willis, the *pneumo-gastric nerve* of the modern French physiologists. This nerve goes off from the common origin of the respiratory nerves, the lateral part of the *medulla oblongata;* it takes its course to the pharynx, the larynx, the lungs, the heart, and stomach. It associates these organs together; which are at the same time supplied with nerves from other sources. Comparative anatomy would lead us to infer that this nerve is not essential to the stomach, as it does not exist but where there are heart and lungs to associate with a muscular apparatus of respiration. That the stomach must be associated with the muscular apparatus of respiration, as well as the lungs, is obvious, from the consideration of what takes place in vomiting and hiccough, which are actions of the respiratory muscles excited by irritation of the stomach.

2. *Respiratory nerve of the face*, being that which is called *portio dura* of the seventh. This nerve, like the last, goes off from the lateral part of the *medulla oblongata*, and, escaping through the temporal bone, spreads wide to the face. All those motions of the nostril, lips, or face generally, which accord with the motions of the chest in respiration, depend solely on this nerve. By the division of this nerve, the face is deprived of its consent

with the lungs, and all expression of emotion. This part of the inquiry will be found very interesting.

3. *Glosso-pharyngeal nerve.* It arises with the last, goes to the back part of the dorsum of the tongue, and to the muscles of the pharynx. It animates the muscles of the fauces in breathing, speaking, coughing, &c.

4. *Superior respiratory nerve of the trunk,* being that which is called *spinal accessory.* This nerve has exceedingly puzzled anatomists, from the singular course which it pursues. It arises from the superior part of the spinal marrow, in a line with the roots of the other respiratory nerves. Instead of going directly out between the vertebræ, as the regular spinal nerves do, it passes up into the skull, comes out through the skull with the par vagum, and, descending upon the neck, goes to the muscles of the shoulder. In this course it supplies muscles, which are already profusely supplied by the regular system of nerves.

This nerve controls the operations of the muscles of the neck and shoulder in their office as respiratory muscles, when, by lifting the shoulders, they take the load from the chest, and fix the farther extremities of the muscles of inspiration seated on the thorax, so as to give them greater power over the ribs. When it was cut across in an experiment, the muscles of the shoulder ceased to co-operate as respiratory muscles, but remained capable of voluntary actions.

5. *Great internal respiratory nerve.* E. The *phrenic* or *diaphragmatic,* of authors. This is the only nerve of the system which has been known as a respiratory nerve.

Its origin, course, and destination, are so familiar to every one, that I shall not say any thing more of it here. But there is another nerve, which has a remarkable resemblance to it, and which, from circumstances already noticed, has been entirely overlooked. This is,

6. *The external respiratory nerve.* This has a similar origin with the preceding nerve. It comes out from the cervical vertebræ, and is connected with the phrenic nerve. It runs down the neck, crosses the cervical and axillary nerves, passes through the axilla and arrives on the outside of the ribs, to supply the serratus magnus anticus, which, it is scarcely necessary to observe, is a muscle already supplied by nerves coming out between the ribs, from the system of regular nerves.

These last-mentioned nerves govern the muscles of the face, neck, shoulders, and chest, in the actions of excited respiration, and are absolutely necessary to speech and expression. But there are other nerves of the same class, which go to the tongue, throat, and windpipe, no less essential to complete the act of respiration. These are the glosso-pharyngeal nerve, and the branches of the par vagum to the superior and inferior larynx*.

We proceed to examine these nerves in detail ; and, first,

---

* It will be seen in the further investigation of this subject, how far the fourth nerve is connected with this system.—See the paper on the Nerves of the Orbit.

OF THE NERVES OF THE FACE, IN WHICH IT IS SHOWN THAT THE TWO SETS OF NERVES, HITHERTO SUPPOSED TO BE SIMILAR, DIFFER IN STRUCTURE, SENSIBILITY, AND FUNCTION.*

It is in the human face that we have the best opportunity of observing the subservience of the nerves to the uses of the parts, and of ascertaining the truth of the preceding doctrines. The face performs many functions possessed by the lower creatures: In it are combined the organs of mastication, of breathing, of natural voice, of speech, and of expression. Here also are seen signs of emotions, over which we have but a very limited or imperfect control: the face may indicate the lowest animal enjoyment, and partakes of the highest and most refined emotions. Happily for our present object, the nerves, which in other parts of the frame are bound together for the convenience of distribution to remote parts, are here distinct, and run apart from each other until they meet at their extremities. They take different courses through the bones of the head, and come out upon the face, exposed in a manner which courts inquiry.

The nerves of the face are, first, the ***trigeminus***, or the fifth of Willis, and that familiarly called the *portio dura* of the seventh, but which, in this paper, will be called *the respiratory nerve of the face*.†

---

* This subject is illustrated by the Plate which represents the nerves of the face.

† I gave this name "respiratory" to mark the difference of the *portio dura* from a common nerve of volition; as possessed of something more than mere voluntary motion, and as associated with the respiratory nerves, and therefore running apart from the fifth.

OF THE TRIGEMINUS, OR FIFTH PAIR, THE NERVE OF SENSATION AND MASTICATION.

In all animals that have a stomach, with palpi or tentacula to embrace their food, the rudiments of this nerve may be perceived; and always in the *vermes*, that part of their nervous system is most easily discerned, which surrounds the œsophagus near the mouth. If a feeler of any kind project from the head of an animal, whether the antenna of the lobster or the trunk of the elephant, it is by a branch of this nerve that it is supplied with sensibility.* But if it be not merely a simple organ of feeling, but in its office connected with respiration, another nerve is added. The trunk of the elephant is not a simple feeler; it is a tube through which it respires, and therefore it has a different nerve superadded, to move it as a hand, and to expand it in the act of inspiration.

From the nerve that comes off from the anterior ganglion of the leech, and which supplies its mouth, we may trace up through the gradations of animals a nerve of taste and manducation, until we arrive at the complete distribution of the fifth, or trigeminus in man. Here in the highest link, as in the lowest, the nerve is subservient to the same functions. It is the nerve of the muscles of the jaws, and of common sensibility, of taste, and of the salivary glands. It comes off from the base of the brain in so peculiar a situation, that it alone, of all the nerves of the head, receives roots both from the column of sensibility and from that of motion. A ganglion is formed upon it near its origin, though some of its filaments pass on without entering into the ganglion. Before passing out of the skull, the nerve splits into three great divisions, which are sent to the face, jaws, and tongue. Its branches go minutely into the skin, and enter into all the muscles, and they are especially profuse to the lips.* The cases in the Appendix give great interest to this statement. Read case, Nos. 13. 57. 68. 59. 60. 61.

---

* The branches of the fifth pair enter the roots of the whiskers of the cat kind, these being feelers, and requiring branches of the sensitive nerve. The following is from a paper by Mr Shaw:—

"In the cat, and in the hare, the branches of the fifth pass not only to the muscles, but also into the whiskers; while the branches of the facial respiratory nerve go past the hairs, and enter into the muscles, moving the tip of the nostril. It is rather difficult to demonstrate the nerves going into the bulbs of the hairs in these smaller animals, but it is easily done in the phoca. A preparation illustrative of this fact was shewn to me some years ago in Amsterdam, by Professor Vrolich; and in the first number of the *Journal de Physiologie Expérimentale,* by M. Magendie, there is an account of "les Nerfs qui se portent aux Moustaches du Phoque," by M. Andral. This fact of anatomy, which has been denied by some, is farther demonstrated by the dissection of those animals which have tufts of hair or whiskers over the eye. In the American squirrel, I have traced the branches of the first division of the fifth into the bulbs of the hairs over its eyebrow."

OF THE PORTIO DURA OF THE SEVENTH NERVE—THE MOTOR AND RESPIRATORY NERVE OF THE FACE.†

This nerve does not exist, except where there is a necessity for some consent of motions to be established between the face and the respiratory organs; and the reason of its circuitous and prolonged course is, that it may associate with the other nerves of respiration. In fishes, this nerve, instead of being distributed forward to the face, passes backward to the muscles of the gills. Indeed, there is, properly, no *portio dura* of the seventh in fishes, the nerve resembling it being a branch of the *par vagum*.* A short description of this nerve in the human body will be necessary to our inquiry.

---

* The reader is referred to the next paper and the explanation of the plates for the more minute anatomy of this nerve. I have often been requested, in vindication of the correctness of my original account of the 5th nerve, to report my early statement of the uses of this nerve. I can give nothing more distinct than in this passage, and I suspect that mistakes on this point have been encouraged and propagated, in consequence of the limited circulation of this work in its first expensive shape of publication.

† *Portio dura nervi acustici. Sympatheticus parvus* by Winslow, *Faciale* by Vicq d'Azyr.

The respiratory nerve of the face arises from the superior and lateral part of the *medulla oblongata*, close to the *nodus cerebri*, and exactly where the *crus cerebelli* joins the *medulla oblongata*. The other respiratory nerves, which form so distinguished a part of the nervous system, arise in a line with the roots of this nerve. When we prosecute this nerve further, we find its roots very peculiar; one flat portion is followed into the pons, whilst another associates it with nerves of respiration.

The nerve, passing into the internal auditory foramen, is here embraced by the *portio mollis;* but it separates from it, and is received into an appropriate canal of the temporal bone. A little farther on, and while within the temporal bone, two cords of communication are formed with the branches of the fifth nerve, or *trigeminus*. One of these is called Vidian nerve, and the other *corda tympani*. By these communications, nerves go in both directions; branches of the seventh are sent to the muscles at the back of the palate; while branches of the fifth nerve (and also of the sympathetic nerve) are brought into the interior of the ear.

By the second of these communications, the *corda tympani*, which joins the lingual branch of the fifth, just where that nerve is passing by the side of the *levator* and *circumflexus palati*,) the branches of this respiratory nerve have access to the *velum palati* and its muscles.

---

* The *portio dura* goes to the blow-hole of the porpoise.

The respiratory nerve of the face, emerging through the stylo-mastoid foramen, divides into many branches, and these diverging, spread to all the side of the face. Let it be recollected, however, that it is here joined by branches of the third division of the fifth nerve. The respiratory nerve having escaped from the temporal bone, divides. First, a branch is sent to the muscles of the outward ear. Another is sent, under the angle of the jaw, to the muscles of the throat, and the pharyngeal plexus. The principal nerve then passes through the parotid gland, and comes upon the face. Here the branches continue to scatter, to go upwards upon the temple and downwards upon the side of the neck, forming on the neck a superficial plexus. The principal branches, however, go forward to the muscles of the forehead and eyelids ; a branch called superior facial is sent to the muscles of the cheek and the side of the nose ; while an inferior facial branch is given to the angle of the mouth, and the muscles which concentrate there.

In this extensive distribution, the nerve penetrates to all the muscles of the face ; muscles, supplied also with the sensitive branches of the fifth pair.

The descending or inferior divisions, which go under the lower jaw, and to the superficial muscles of the throat and neck, are connected with branches of the spinal nerves, and with the respiratory nerves ; as may be seen in the plate.

The relative proportion of the facial respiratory nerve to the fifth, is greater in man than in any other animal. If we descend to the next link in the chain of beings (the monkey), we shall find the proportion of it to be much diminished, and that of the fifth increased. The distribution of the nerve is more complicated in the monkey than in the dog, its intricacy being apparently in proportion to the number of muscles of expression. From the lion, the dog, and cat, we descend to the horse, ass, and cow : in these animals there is a marked difference in the distribution of the nerve, from that of either the monkey or the dog ; for, excepting a few branches, which pass to the muscles of the external ear, and to the eyelid, the whole of the respiratory nerve is confined to the muscles of the nostrils and side of the mouth, while in the carnivorous tribes it is spread in great profusion over the cheeks and side of the neck.

There are, however, some varieties in the classes of graminivorous animals. In the gazelle, sheep, and deer, the distribution of the nerve is still more simple than in the horse ; while in the camel it is more profuse, and is, in this respect, intermediate between that of the carnivorous and the graminivorous animals. The expression of the enraged camel is sufficiently ferocious ; and the manner in which he shows his tusks, when dying, is very similar to that of a carnivorous creature.

If we were barely to consider this distribution of the *portio dura* of the seventh, unbiassed by theory or opinion, we should be forced to conclude, that it is not alone sufficient to supply any one part with nervous power, for every one of its branches is joined by divisions of the fifth. The question then naturally arises, whether these nerves perform the same function ? whether they furnish a double supply of the same property or endowment, as so many of our best authorities have supposed ; or perform different offices ? Having taken all the assistance that the knowledge of the human structure and comparative anatomy affords, we are prepared to decide the matter by experiment.

EXPERIMENTS ON THE NERVES OF THE FACE, WITH A VIEW TO ASCERTAIN THE USES OF THE PORTIO DURA.

If an ass be thrown, and the *portio dura* be cut across where it emerges upon the face, before the ear, all the muscles of the face, except those of the jaws, will be paralysed. If its nostrils be confined for a few seconds, so as to make it pant and forcibly dilate the nostrils at each inspiration, and if the *portio dura* be now divided on one side of the head, the motion of the nostril of the same side will instantly cease, while the other nostril will continue to expand and contract in unison with the motions of the chest.

On the division of this nerve, the animal will give no sign of pain ; or in no degree equal to what results from dividing the fifth nerve*.

If an ass be tied and thrown, and the superior maxillary branch of the fifth nerve exposed, touching this nerve gives acute pain. When it is divided, no change takes place in the motion of the nostril ; the cartilages continue to expand regularly in time with the other parts which combine in the act of respiration ; but the sensibility is entirely lost. If the same branch of the fifth be divided on the opposite side, and the animal let loose, the parts will be deprived of sensibility, and he will not pick up his corn : the power of elevating and projecting the lip, as in gathering food, will appear to be lost. He will press the mouth against the ground, and at length lick the oats from the ground with his tongue. In my first experiments the loss of sensibility of the lips was so obvious, that it was thought a useless cruelty to cut the other branches of the fifth*.

---

* In the Plate the branches of the fifth or sensitive nerve are seen to join and incorporate with the portio dura, so that the nerve, when cut anterior to this junction, must exhibit signs of sensibility.

The experiment of cutting the *portio dura*, gave so little pain, that it was several times repeated on the ass and dog, and uniformly with the same effect. The side of the face remained at rest and placid, during the highest excitement of the other parts of the respiratory organs.

When the ass, on which this muscular nerve of the face had been cut, was killed by bleeding, an unexpected opportunity was offered of ascertaining its influence, by the negation of its powers on the side of the face where it was cut across.

When an animal becomes insensible from loss of blood, the impression at the heart extends its influence in violent convulsions over all the muscles of respiration; not only is the air drawn into the chest with sudden and powerful effort, but at the same instant the muscles of the mouth, nostrils, and eyelids, and all the side of the face, are in a violent state of spasm. In the ass, where the *portio dura* had been cut, the most remarkable contrast was exhibited in the two sides of the face; for whilst the one side was in universal and powerful contraction, the other, of which the nerve was divided, remained quite placid†.

---

* The cases in the Appendix prove in a more agreeable way the fact, that when the facial branches of the fifth pair of nerves are cut, insensibility results without loss of motion. See No. LI., Appendix.

My late excellent brother-in-law, Mr John Shaw, repeated my experiments on the roots of the spinal nerves, and when I had stated my conviction that it would be found that those two nerves of the face differ in their functions; and when the proofs came out so satisfactorily under his own hands in these experiments, nothing could exceed his delight. It is well known with what interest he prosecuted the subject, at once honourable to himself, and to me.

† Read the case of Paralysis of the Face, in the Appendix, where the expression of a woman in labour was confined to one side. A frightful expression of countenance was produced by the same cause in a patient dying.—See Case XXXIX.

From these facts we are entitled to conclude, that the *portio dura* of the seventh is the nerve of motion to the muscles of the forehead, eyebrow, eyelids, nostril, lips, and ear; that is, to all the muscles of the face except those of mastication—that it is the respiratory nerve of the face; that the motions of the lips, the nostrils, and the velum palati, are governed by its influence, when the muscles of these parts are in associated action with the other organs of respiration. We cannot fail to acknowledge the necessity of this relation: These passages to the lungs are membranous tubes, moved by muscles, which serve to expand and widen them, so that the air may freely enter into the lungs. It is obvious that, to produce this expansion, these muscles must have a consent with the other muscles of respiration, and move simultaneously with them; and this is effected through the respiratory nerve of the face.* It will be proved in the sequel, that the throat, neck, shoulders, and chest, have similar nerves to this, similar in distribution and function; and that these unite all the extended apparatus of breathing and speaking.

The actions of sneezing and coughing are entirely confined to the influence of the respiratory nerves. When carbonate of ammonia was put to the nostrils of the ass whose respiratory nerve on one side had been cut, that side of the nose and face, where the nerves were entire, was curled up with the peculiar expression of sneezing; but on the other side, where the nerve was divided, the face remained quite relaxed, although the branches of the fifth pair and the sympathetic were entire. The respiratory nerve of one side of the face of a dog being cut, the same effect was produced; the action of sneezing was entirely confined to one side of the face.

---

* In the Appendix, the defect from paralysis of the nostrils is made apparent. The same is shewn in the detail of Daniel Quick's Case. A more curious example is presented in No. VI., where it is seen, that if the patient lay with the nostril of the sound side pressed against the pillow, he was under the necessity of actually holding the paralytic nostril open with his fingers, in order to breathe freely.

These last experiments shew, that the peculiar expression in sneezing results from an effect on the respiratory nerves, and that the muscles of the face are drawn into sympathy solely by the influence of the respiratory nerve of the face. It will appear that the property of receiving impression is not actually lost by the division of this facial muscular nerve, but the corresponding expression is quite destroyed.*

There is no part of the nervous system of which the anatomy has been more negligently consulted in forming our physiological opinions, than that which regards the office of the sympathetic nerve. The connexions of this nerve, or rather system of nerves, being universal, it has been supposed that it is the cord through which the relations of the eye, nose, face, throat, diaphragm, &c., are established, and especially in expression; whereas the combination is effected solely through those nerves which, from their grand or leading function, I have called the respiratory nerves. When the sympathetic nerve was left entire while the respiratory *portio dura* was cut, no sympathy pervaded the features. The sympathetic nerve is therefore not the source of that sympathy which produces expression.

It had been presumed, that the act of smiling is peculiar to the human countenance, and that in no other creature can there arise that state of enjoyment which produces this distinguishing character of the human face, the affection of benevolence, or the enjoyment of the ridiculous. But every one must have observed how near the approach is to this expression in a dog, when he fawns on his master, and leaps and twists his body and wags his tail, while at the same time he turns out the edge of the lips as like a laugh as his organs can express. When the respiratory nerve on one side of the dog's head was cut across, there was no longer this motion of the lips, although it was still observable on the other side, where the nerve was entire.

---

* See again Daniel Quick's Case, Appendix, No. VII.

On cutting the respiratory nerve on one side of the face of a monkey, the very peculiar activity of his features on that side ceased altogether. The timid motions of his eye-lids and eyebrows were lost, and he could not wink on that side; and his lips were drawn to the other side, like a paralytic drunkard, whenever he shewed his teeth in rage. Considering these facts, the conclusion is inevitable, that the motions of the lips, nostrils, and eye-lids, and forehead, in expression, have nothing to do with the fifth pair of nerves, nor with the nervi molles, branches of the sympathetic nerve, which accompany the blood-vessels of the face.

In the Appendix we have proofs equal to experiments, that in the human face the actions of the muscles which produce smiling and laughing are a consequence of the influence of this respiratory nerve. A man had the trunk of the respiratory nerve of the face injured by a suppuration which took place before to the ear, and through which the nerve passed in its course to the face. It was observed, that in smiling and laughing, his mouth was drawn in a very remarkable manner to the opposite side. The attempt to whistle was attended with a ludicrous distortion of the lips: when he took snuff and sneezed, the side on which the suppuration had affected the nerve remained placid, while the opposite side exhibited the usual distortion.

Thus it appears, that whenever the action of any of the muscles of the face is associated [with the act of breathing, it is performed through the operation of this respiratory nerve, or *portio dura.* I cut a tumour from before the ear of a coachman : a branch of the nerve which goes to the angle of the mouth was divided. Some time after, he returned to thank me for ridding him of a formidable disease, but complained that he could not whistle to his horses.*

Thus it appears that the *portio dura* of the seventh nerve is the principal muscular nerve of the face ; that it supplies the muscles of the cheek, the lips, the nostrils, and the eye-lids ; that is, that it is the nerve which orders all those actions that have even the remotest connexion with the act of respiration. It is possible that those relations may not be apparent at first, but in the prosecution of this subject we shall discover the reasons of those links by which the respiratory organs are combined with the actions of the features.

OF THE FUNCTIONS OF THE TRIGEMINUS, OR FIFTH NERVE.

As soon as the proper distinctions in the functions of these facial nerves are made, facts multiply upon us. We have seen that when the fifth nerve, the nerve of mastication and sensation, was cut in an ass, the animal could no longer gather his food. It was found, that on cutting the infra-orbitary branch of the fifth nerve on the left side, and the *portio dura*, or respiratory nerve, on the right side of an ass, the sensibility to pain on the right side, where the *portio dura* of the seventh nerve was cut, remained entire, while that of the left side was completely destroyed by the division of the fifth. It was also apparent in this experiment, as in the others, that there was the most marked difference in the sufferings of the animal, when these nerves were cut across. The cutting of the fifth nerve gave pain in a degree corresponding with our notions of the sensibility of nerves; but in cutting the *portio dura*, it was not evident that the animal suffered pain at all.

---

* Of this we have now abundant proofs—see the cases in the Appendix. The only subject of surprize is that these circumstances should have been so long unobserved.

Independently of the difference of sensibility in these nerves, there was exhibited, in all these experiments, a wide distinction in their powers of exciting the muscles. The slightest touch on the *portio dura*, or respiratory nerve, convulsed the muscles of the face, whilst the animal gave no sign of pain. By means of the branches of the fifth nerve, it was not possible to excite the muscles, if the trunk of the nerve were divided behind the part bruised; that is to say, if the communication with the sensorium were cut off.

I divided the branch of the fifth pair, which goes to the forehead, in a man, at his urgent request, on account of the *tic douloureux*; there followed no paralysis of the muscles of the eyebrow. But in another case, where an ulcer and abscess seated anterior to the tube of the ear affected the superior branch of the respiratory nerve, the eyebrow fell low, and did not follow the other when the features were animated by discourse or emotion.*

Facts multiply upon us daily, if our attention be kept awake by a knowledge of the anatomy of these nerves. I had a patient in whom there was loss of sensibility in the side of the face and tongue from disease of the fifth, while the motions of the features remained. The case is detailed in the Appendix, and in the next paper.*

---

* This is more particularly illustrated by the division of the fifth nerve, see No. LVI. of the Appendix.

Thus experiments and occurrences in practice leave no doubt as to the distinct offices of the two nerves of the face; and that the fifth nerve is the sole cause or source of the common sensibility of the head and face.

The following circumstance occurred to a very learned and ingenious gentleman. Suffering under the pangs of toothach, he took the sudden resolution of having his tooth drawn, and by an inexperienced hand: a grinder of the lower jaw was extracted. On putting a tumbler of water to his lips, he said, Why have you given me a broken glass? he found presently that the glass was entire, but that he had lost the sensation of one half of his lower lip. He thought that he put half a glass to his lips, because the lip had been deprived of sensation in one half of its extent. He retained the power of moving the lip, but not of feeling in it: and now, after some years, he does not know when a portion of food, or a drop, hangs on that side of the lip, although there be not the slightest impediment in its motions.

This circumstance is explained on referring to the plate, for there is a branch of the fifth nerve called *mandibulo-labialis*, coming through the jaw, to be given to the lip. This nerve was undoubtedly hurt where it take its course in the jaw under the roots of the teeth, and the consequence was the loss of sensation in the one half of the lip which is supplied by it. It is equally important in this investigation to observe, that although the sensibility of the lip was destroyed by the injury of the branch of the fifth, the motion of the lip remained entire through the operation of the *portio dura*.*

---

* See also the case of division of the suborbitary nerve, in the Appendix.

In the above statement there are some facts regarding the feeding of animals which are of difficult explanation, until we consider what is necessary to the simple act of feeding. When a horse gathers the oats from the hand or from the ground, he must feel the food, which is the office of the branches of the fifth ; he must move his lips under the direction of that feeling, or he cannot gather it. It was accordingly discovered by experiment, that whether the seventh or the fifth were cut, if the operation were done on both sides of the face, the creature was deprived of the power of feeding, but from different causes; for in the first experiment it was owing to the loss of motion, and in the second to the loss of sensation.

I have found in a man, that, when the cheeks and lips were twisted by paralysis, he possessed the power of holding with his lips in a manner that indicated a power independent of the seventh. Now this might be a defect of one of the endowments of the seventh whilst another remained; or it might have been owing to a branch of the fifth going forwards to the buccinator. We shall not discuss this here, as it is the subject of the second paper.†

---

* A case exactly similar is narrated in the Appendix, No. XXXVIII.

† Mr Shaw, in a paper on this subject, says, " In the case of a little girl, the consequence of disease of the right *portio dura* is very striking. When she laughs heartily, the right cheek and the same side of the mouth are unmoved, while the muscles of the left side are convulsed with laughter.

" If told to laugh with the right side, she raises the angle of the mouth, but by an action which is evidently regulated by the fifth pair. This attempt to laugh gives a peculiarly droll expression to her face." But be-

It will be asked, why a nerve called *respiratory* should go to the ear and the eye?* First, let us inquire, Whether it belongs to the frame of animal bodies that there shall be in them indications of passion? If it be admitted that this is the case, we here learn in addition, that as the *portio dura* is the nerve of respiration, so it is the grand nerve of expression, not only in man, but in brutes also. All that excitement which is seen in a dog's head, in his eyes and ears when fighting, disappears, if this nerve be cut. The respiratory nerve being cut across in a terrier, the side of the face was deprived of all expression, whether he was made to crouch, or to face an opponent and snarl. When another dog was brought near, and he began to snarl and expose his teeth, the face became twisted to one side, to that side where the nerve was entire; and the eyelids being in this state of excitement, very differently affected, presented a sinister and ludicrous expression.

On cutting the respiratory nerve of the face in the carnivorous animals, it did not appear that the action of feeding was left so entire as in the graminivorous animals. This gave me reason to reflect on the different natures of the two classes. The beast of prey procures his food under the influence of a blood-thirsty appetite, and suffers a universal excitement; he holds and rends his prey; and especially in the larger animals of this class, the action of feeding is accompanied with horrific sounds of enjoyment; in short, with a highly excited state of the organs of respiration. In the graminivorous

---

fore we decide on this matter, we must determine whether even the *portio dura* of the seventh nerve may not lose one faculty and retain another. I suspect that the influence of passion, as those of smiling or laughing, is lost in consequence of affections that do not destroy the entire power of the nerve.

* See a succeeding paper on this curious subject.

animals, the act of feeding is a simple and unimpassioned exercise of the organs of mastication.

These experiments will, it is hoped, be deemed conclusive; yet it is a pleasanter mode of investigation to have recourse to comparative anatomy. There is only one additional instance of this kind that he will offer. It has been already stated that when a feeler, or antenna, is examined, if it be simply for sensation, one nerve only runs along it. It was suggested, that if this theory were true, the trunk of the elephant being hollow, and connected with respiration, it should have two nerves; whereas, in the observations of Cuvier, it was stated to have only one; but on examination, it was found that large branches, nearly equal in size, of the *portio dura* and of the fifth took their course along the trunk.*

---

* Mr John Shaw had an opportunity of dissecting the trunk of an elephant. He says, "From the great power which the elephant has over its trunk, I was certain that there must be large nerves running to it, similar to those which supply the fingers in man; but as the proboscis forms an important part of the respiratory system of this animal, I thought in the dissection of it there would be the most distinct proof of the accuracy or fallacy of Mr Bell's opinions on the subject of the *portio dura*.

"The trunk was found to be supplied not only by branches of the fifth pair, as described by Cuvier, but also by a very large branch from the *portio dura* of the seventh pair.

"The *portio dura* in this elephant was found emerging from the parotid gland, as in other mammalia. It gave off some descending branches to the neck, but passed from behind the jaw to the proboscis, almost as an entire nerve, and of the size of the sciatic nerve in man: in its course it only gave some small branches to the muscles of the eye, to those of the ear, and to a small muscle which corresponds with the platysma. Before it passed into the substance of the proboscis, it united with the second division of the fifth pair, which comes forward from the infra-orbital hole, in two large branches. The two nerves being then closely united, passed between the layers of the muscles, which form the greater mass of the trunk. The *portio dura* became quickly diminished in size, as it gave off its branches in great profusion to the muscles: but the fifth was continued down, as a very large nerve, to nearly the extremity of the trunk;

SOME FURTHER REMARKS ON THE DISEASES OF THE NERVES OF THE FACE.*

WERE we to inquire no further, and to rest contented with the inference, that the two sets of nerves distributed to the face have distinct functions; even this must prove useful both to the surgeon and physician. To the surgeon it must be useful in performing operations on the face, as well as in observing the symptoms of disease. If we have to plan an incision on the face, we must take especial care to avoid cutting the branches of the seventh nerve, for if it be divided, there will be paralysis of the muscles supplied by that nerve. Whereas, if we divide the fifth nerve, though there may be more pain during the operation, and a defect of sensibility following it, no unseemly distortion will be produced. To produce paralysis as a consequence of an operation which was meant to remove deformity, is an unfortunate mistake; but even worse consequences may result from an ignorance of the distinct nature of these nerves; if, trusting to the eyelids being supplied by the branches of the fifth nerve, a surgeon, in opening an abscess or cutting out a tumour, should cut the division of the seventh which goes to the eyelids, the consequence would be very unfortunate. The eyelids thenceforward would stand apart, the eye would

---

in this respect resembling the nerves to the fingers in man. On making sections of the proboscis, near it's extremity, a great number of these nerves were seen in its substance.

"A few branches of the *portio dura* ran to the valvular apparatus in the upper part of the trunk; but this peculiar structure was supplied principally by a branch from the fifth pair, which winded round under the orbit.

* So little attention had been given by men of science to the Speculations on the Nervous System at this time, that I have endeavoured to shew to the gentlemen of the Royal Society that the subject was of direct practical benefit.

be permanently uncovered and inflamed. From this inflammation the cornea becomes opaque, and the vision of the eye injured or altogether lost.

By a knowledge of the distinct functions of the nerves of the face, combined with a knowledge of their roots or origins in the brain, we become better able to comprehend symptoms when they are consequent on disease in the bones, or in the base of the brain, or when they result from injury to the skull or brain, as in the case of gun-shot wounds.*

To the physician the facts ascertained in this paper must also be important: he will be better able to distinguish between that paralysis which proceeds from the brain, and that partial affection of the muscles of the face, when, from a less alarming cause, they have lost the controlling influence of the respiratory nerve. How often have I seen an inflamed gland affecting a branch of the *portio dura* mistaken for a disease in the brain itself, because it was not known that, although the fifth nerve was free, the pressure on the seventh nerve was sufficient to paralyse the muscles of the side of the face †. That the disease of the bone at one time affects the fifth nerve, producing excessive pain of the face without paralysis; and that it, at another time, affects the seventh nerve, inducing paralysis without pain; are now phenomena accounted for.

It is very frequent for young people to have what is vulgarly called a blight, from exposure to cold; by which is meant a slight palsy of the muscles on one side of the face. Inflammation of glands seated behind the angle of the jaw will sometimes produce this. Before these observations, it would have been said, that paralysis could not be so produced, because the parts are plentifully supplied by the branches of the fifth nerve; that the disease must be in the brain. The occurrence is repeatedly referred to in the Appendix. All such affections of the respiratory nerve will now be more easily detected, even in their most equivocal state. The patient has a certain command over the muscles of the face; he can close the lips; and the features are duly balanced: But the slightest smile is immediately attended with distortion, and in laughing and crying the paralysis becomes quite distinct. But there are degrees in this paralysis. If the nerve be quite destroyed, the muscles of the jaws only retain their action.

---

* Abundance of cases in the Appendix sufficiently prove the consequences of cutting across the *portio dura*, and that the surgeon must avoid dividing this nerve.

† In the Appendix, numerous cases shew the importance of this fact.

The fact appears to be, that the respiratory motions of the face produced by the influence of this nerve are subject to derangement from slight causes; by causes which do not influence the general nervous system, nor even the other functions of the seventh nerve. We shall see in the third paper, that this character belongs to other branches of the same system in their distribution to the trunk.*

The knowledge of the sources of expression teaches us to be more minute observers. The author had lately to watch the breathing of an infant which had been several times restored from a state of insensibility. At length the general powers fell low, without any returning fit; insensibility and loss of motion stole over the frame; all but the actions excited by the respiratory nerves ceased; then each act of respiration was attended with a twitching of the muscles of the *ala nasi*, and of that muscle of the cheek which makes the dimple in smiling. It was then evident that the child could not recover, that all but the system of respiratory nerves had lost their powers, and the consideration that these are the last to die shewed too plainly that actual death approached. In death, the voluntary actions cease first; then sensation is quite lost. The actions of respiration survive; become convulsive, with heaving of the chest; then irregular; then cease;—the last act of life being a convulsive drawing of the platysma myoides and the muscles of the cheeks and nostrils,—after which all is still.

---

* See the great variety of cases of spasmodic affections of the portio dura, and other respiratory nerves, in the Appendix.

A patient being in extreme danger, however debilitated, we leave him in the conviction that death does not yet approach; but when the respiratory organs are agitated, then the act of dying has commenced.

There are conditions of the lungs, in which the patient is in great danger, and yet the inflammation is not marked by the usual signs of pain and difficult motion of the chest. We shall see nothing but the twitching of those muscles of the face, which are animated by the respiratory nerve. We see a certain unusual dilatation of the nostrils, and a constrained motion of the lips, which, with the change of voice, are just sufficient to give alarm, and indicate the patient's condition. This is a state of the lungs very often produced after severe accidents, as gun-shot wounds, and after great surgical operations.

These circumstances are stated to prove, that the subject of expression is not foreign to medical studies; and certainly, by attention to the action of the muscles of the face, we shall find the views drawn here from the anatomy farther countenanced. We learn that smiling is an affection of the nerve of respiration on the muscles of the face, and that when laughter shakes the sides, it is only an extended and more convulsive action of the muscles, produced by the same class of nerves. When to the paleness and coldness and inanimation of grief, there is added the convulsive sob and the catching of the throat, and the twitching of the lips and nostrils, we discover the same class of nerves to be affected, which, in crying, are only more obviously in operation, producing more violent contractions.

CONCLUSION.

When the account of the nerves of the throat, neck, and chest, shall be laid before the Society, as those of the face have now been; and when a comparison shall be made of the varieties in nerves corresponding with the changes in the mechanism of respiration in different animals; a juster estimate will be formed of the importance of these observations. Then the same distinctions of structure and function, which are made manifest in the nerves of the face, will be observed in nerves which take an extensive course through the body. We shall be able to distinguish and separate the nerves of respiration, amidst the apparent intricacy of the general system. By cutting across these nerves of respiration, we shall find it possible successively to stop the motions of the several parts, which unite in the act of respiration; not only to stop the motion of the diaphragm, but the motions of the side, of the shoulder, of the larynx or the pharynx, by cutting their respective respiratory nerves. When this is done, they will be left in the exercise of their other functions through their other nerves, and still alive to other excitements, and capable of performing the voluntary motions, though dead to the influence of the heart and lungs.

By thus distinguishing the nerves of respiration, and as it were separating them from the others, we reduce the remaining part of the nervous system to comparative simplicity. The seeming intricacy in the branching of the nerves, their convergence to certain organs from different origins, their re-union and divergence, instead of being a source of confusion, become a subject of the highest interest. The re-union and crossing of nerves we now ascertain to be for the purpose of associating the muscles into different classes; for combining them in subserviency to different organs; and placing them under the guidance of a sensibility more certain in its operation than the will.

And now it may be once more asked, why is the *portio dura*, the muscular nerve of the face, separated from the fifth pair? Is it an accidental circumstance? No, certainly: It is a dangerous principle to admit chance in a matter of this kind: it cannot be an accident, which directs a distribution so uniform through all the varieties of animals which breathe. It is ordered for the ends so often hinted at in these papers—that the organs in the face may be associated with those of the neck, larynx, pharynx, &c. The nerve separates from the fifth, and joins the glosso-pharyngeal and laryngeal, and the roots of the phrenic, that all the parts supplied by these nerves may be combined together, and that a sympathy may exist among those parts which would remain disjoined in excited breathing and speaking, were there no other nerves than the regular and symmetrical nerves of the spinal marrow.

ON THE NERVES OF THE FACE.

things were proved :—First, that the sensibility of the head and face depended on the fifth pair of nerves; Secondly, that the muscular branches of the fifth were for mastication; And, in the third place, that the portio dura of the seventh, or respiratory nerve of the face, controlled the motions of the features, performing all those motions, voluntary or involuntary, which are necessarily connected with respiration,—such as breathing, sucking, swallowing, and speaking, with all the varieties of expression.*

Reserving the details, I shall now state shortly the occurrences which I have witnessed since the publication of that paper; as they afford convincing proofs of the correctness of these opinions.

The first instance was in a man shot with a pistol ball, which entered the ear and tore across the portio dura at its root. All motion on the same side of the face from that time ceased; but he continued in possession of the sensibility of the integuments of that side of the face.

The next instance was in a man wounded by the horn of an ox. The point of the horn entered under the angle of the jaw, and came out before the ear, tearing across the portio dura. He remains now a singular proof of the effects of the loss of function in the muscles of the face in consequence of the division of this nerve. The forehead of the corresponding side is without motion; the eye-lids remain open; the nostril has no motion in breathing; and the mouth is drawn to the opposite side. The muscles of the face by long disuse have degenerated; and the integuments of the wounded side of the face have become like a membrane stretched over the skull; they have lost their firmness, and the flesh under them is wasted, with the exception of certain muscles: The cause of which will be understood on perusing the anatomical description in the present paper. In this man the sensibility of the face is perfect.

---

* The portio dura has an origin which permits it to hold connection with the column of voluntary motion, and with the common origin of the respiratory nerves.

The same nerve (portio dura) has been divided in the extirpation of a tumour from before the ear; and the immediate effect has been horrible distortion of the face by the prevalence of the muscles of the opposite side, but without the loss of sensibility; and that distortion is unhappily increased when a pleasurable emotion should be reflected in the countenance.

These facts are so distinct, that I cannot presume to detain the Society with the instances of the lesser defects which I have witnessed from the more partial injuries or temporary diseases of the nerve;—such as distortion of the features produced by glands pressing on this nerve; paralysis from suppurations in the ear affecting the nerve in its passage, or temporary derangement disturbing one or more of its functions.

As to the fifth nerve, the facts are equally impressive, and correspond with our former experiments and opinions. By a small sacculated tumour affecting the roots of this nerve, the sensibility was destroyed in all the parts supplied by its widely extended branches; that is, in all the side of the head and face and the side of the tongue; and the muscles of the jaws were wasted, whilst the motion of the face remained. Two circumstances affecting this nerve have occurred with most curious coincidence in the symptoms. By the drawing of a tooth from the lower jaw, the nerve which comes out upon the chin to supply one half of the lip was injured, and exactly this half of the lip was rendered insensible. When the patient put his mouth to a tumbler he thought they had given him a broken glass! Precisely the same thing occurred from the division of that branch of the fifth nerve, which goes to one half of the upper lip. A gentleman falling, a sharp point entered his cheek and divided the infra-orbitary nerve: the effect was loss of sensation without loss of motion, in that half of the upper lip to which the nerve is distributed. The remarkable circumstance was, that this person made the same remark when the cup was put to his lip,—that they had given him a broken one! The part of the cup which was placed in contact with the insensible portion of the lip appeared to him to be broken off.

I have had two or three instances before me of disease affecting the ophthalmic branch of the fifth nerve, and producing total insensibility of the eye and eye-lids, without loss of vision; whilst the eye-lids continued to be closed and the eye-brow to be moved by the influence of the portio dura of the seventh nerve.

Such are a few of the facts which have resulted from a patient reliance on the correctness of my first deductions, and I would now urge them in proof of the importance of reasoning upon the anatomy. All these nerves have been repeatedly divided, by almost every surgeon of eminence in the three kingdoms. Although some have performed the operation of dividing the nerves frequently, and one eminent gentleman had done it six times on the face of the same man, all these operations have been performed without giving rise to the suspicion that these nerves bestowed different properties. Even now, (so slow is the progress of improvement), it is stated by a surgeon that he will not hesitate to cut the portio dura in the case of tic douloureux. My duty is performed when I give publicity to the facts which prove that horrible distortion of the whole countenance, the loss of distinct articulation, the loss of expression, the loss of motion of the eye-lids, and consequent inflammation of the eye, must follow such an operation.

Much has been said in favour of experiments when made by men who are positively without any expectation of the result; or, as they affirm, are unbiassed. The only instances of this that I can allow, are when the surgeon cuts the nerves of the face in a surgical operation. In such operations as these for tic douloureux, he is indeed unbiassed; and we have seen the result, that after fifty years of such experience we remained quite ignorant of the distinctions in these nerves. But, on the other hand, when attention is roused to inquiry by anatomy, facts are obtained of the utmost importance both to the knowledge of disease and to the safe practice of surgery.

OF THE MOTOR OR MANDUCATORY PORTION OF THE FIFTH NERVE.

The fifth nerve is usually called Trigeminus, from piercing the skull in three grand divisions. But when it has been shewn that it is composed of two distinct roots having different functions, the accidental circumstance of its divisions passing through the bones yields in importance to another inquiry, How is the muscular portion of the nerve distributed?

Since the publication of my first paper this inquiry has assumed importance; although the principal facts of the anatomy were known to Wrisberg, Santorini, Paletta, Prochaska, and Sœmmerring.* But in no author is the anatomy of the motor portion of the nerve traced with sufficient minuteness, or regard to the distinct uses of the muscular and sensitive divisions.

---

* As I have not read his paper with sufficient attention, I may be doing

The motor division of the fifth nerve corresponds with the anterior root of the spinal nerves; it passes under the Gasserian ganglion, and free of it. It is not seen when we look from above; as in the plates of Monro. When the nerve is turned up and dissected, this portion is seen to form about a fifth part of the whole nerve. It is tied to the larger portion before advancing to the ganglion, by filaments which have been sometimes taken for nerves.

Having passed the ganglion, it attaches itself slightly to the superior maxillary nerve, but this is apparently a membranous connection only.[*] The nerve itself joins the third grand division after passing the foramen ovale. At this point the muscular and sensitive portions of the nerves are matted together, and form a mass which between the fingers feels like a knot.[†] There is, however, no red and fleshy-like matter interposed here, as in the Gasserian ganglion of the trunk of the nerve. But the filaments of both portions of the nerve are here so complexly and intimately combined, that all the branches which go off after this union are compound nerves, and have motor filaments in their composition.

It is, however, equally obvious that the gustatory division of the nerve which descends from this mass has not the muscular portion given to it in that abundance which those branches have which take their course to the muscles of the jaws. The mandibulo-labralis, which also de-

---

injustice to *Dr Niemeyer* of *Halle,* who writes on the Anatomy of the Fifth Nerve in Reil's Journal.

[*] Gerardi, commenting on Santorini, says that the anterior root (the motor) does give filaments to the superior maxillary division of the fifth. Prochaska (de Structura Nervorum) gives two views, tab. ii. fig. v. vi., which represent an actual union of the anterior root with the superior maxillary nerve. In the plate, however, the twigs seem rather to go from the ganglionic into the motor division.

[†] Santorini says, it is a plexus like a ganglion, "in plexum vere ganglioformem mutatur."

scends from this plexus, lies nearer to the motor portion, and has a more distinct addition given to it than the gustatory nerve.

This motor or muscular portion which we are tracing sends off no branch either in its course under the great ganglion, or after passing it about half an inch. But when it has arrived at the point of union with the ganglionic portion, the filaments become interwoven; and from this place the nerves are compound, and go off diverging to their destinations. First, there are sent off nerves to the temporal, masseter, and pterygoid, muscles, also to the buccinator muscle. The temporal muscle receives a large and appropriate nerve. The nerve to the masseter passes between the coronoid and condyloid processes of the lower jaw-bone; but before going into the muscle it sends branches to the temporal muscle. The pterygoid muscles have each their appropriate nerves coming directly from this plexus.

RAMUS BUCCINALIS LABIALIS.

This is a remarkable branch, which arises from the same source, and goes to the cheek and lips. This nerve, where it lies on the external pterygoid muscle, sends one more branch to the temporal muscle; it then divides, one branch enters the buccinator muscle, and another is prolonged forwards. The division to the buccinator muscle is tortuous, which is no doubt a provision for its being undisturbed by the free motion of the cheek; its minute branches may be traced until lost among the muscular fibres, whilst others penetrate to the lining of the cheek. The prolonged branch is the labial division; it runs nearer the alveolar processes of the lower jaw, and becomes so superficial as to admit a union with the portio dura: from thence, passing under the facial artery, it may be traced into the triangularis or depressor anguli oris, the levator labiorum communis, and the lateral portion of the orbicularis oris.

In the distribution of the buccinalis labialis to the muscles of the mouth, it is joined, as I have said, by branches of the portio dura; and nothing is more striking than the manner in which this latter nerve passes over the masseter, a muscle of the jaw, to be profusely given to the muscles of the lips.

There is one more branch important to the physiology of the fifth nerve. At the root of the mandibulo-labralis (where it is sent off from the junction of the muscular and ganglionic portions) a small nerve takes its origin. This branch runs parallel to the greater nerve till it enters the foramen in the lower jaw; here it seems to enter, but does not; it takes a course on the inside of the jaw to arrive at its final destination, the mylo-hyoideus and the anterior belly of the digastricus, that is, to those muscles which open the mouth by drawing down the jaw.

We may for a moment interrupt our particular inquiry, to notice that all muscular nerves, and consequently the muscular divisions of the fifth nerve, form a plexus. The plexus, formed by the motor and ganglionic divisions of the fifth nerve before they diverge to the muscles of the lower jaw, corresponds with the plexus formed on the nerves sent to other classes of muscles. Even that branch of the third division of the fifth nerve which comes out before the ear joins the portio dura in a plexus;* and this is the reason of that sensibility evinced in the facial nerve in making experiments upon it.

The form of the fifth nerve, and its resemblance to the spinal nerves, had struck some of the best continental anatomists. But as they had not made out the distinctions in the functions of the roots of the spinal nerves, so neither did they imagine any difference in the roots of the fifth nerve; and therefore no consequence resulted from having observed this resemblance. This part of the anatomy, together with the whole minute relations of the nerves, was a dead letter, and led to no inference.

---

* See the adjoined Plate.

But now resuming the course I have hitherto followed, the anatomy of the fifth nerve points to curious results. We see that the motor division of this nerve goes first to the muscles which close the jaw and give it the lateral or grinding motions. Secondly, we see that it is distributed to the muscles of the cheek, which place the morsel under the operation of the teeth; and, thirdly, we find it going to the muscles which open the jaws.

We proceed to the second method of proof, by experiment. Does the fifth nerve move the jaw? Is it indeed the manducatory nerve as suggested by the anatomy? Let the following experiments determine the fact.

Experiment I.—The root of the fifth nerve being exposed in an ass and irritated, the jaws closed with a snap.

Experiment II.—The fifth pair being divided in an ass, the jaw fell relaxed and powerless.

If we consider the action of mastication, we shall see what the consequence would be, were there no accordance between the motions of the lower jaw and the cheeks. Conceiving that there must be such an accordance, and contemplating the roots of the fifth pair and their distinct functions, I had imagined that this office was performed by the branches of the second division of the fifth. But finding that the connexion between the motor root and the superior maxillary nerve proved to be only by cellular texture, and considering the affirmation of M. Magendie and those who followed him, that the infra-orbitary branch had no influence upon the lips, I prosecuted with more interest the Ramus Buccinalis Labialis. And nobody, I presume, will doubt that the distribution of this division confirms the notions drawn from the anatomy of the trunk,—not only that the fifth nerve is the manducatory nerve as it belongs to the muscles of the jaws, but also that it is distributed to the muscles of the cheek and lips to bring them into correspondence with the motions of the jaws. Let us take in illustration the articulation of the bones. In the joints, the muscles are attached to the capsular membrane in such a manner as to draw it from between the bones and adapt it to the degree of flexion of the joint. If the cheek were a passive membrane like the capsule of a joint, it would have required some such mechanical connexion with the jaw or its muscles, as might have drawn it from between the teeth in the motions of mastication. But being a muscular part, to bring it into just relation with the motions of the teeth, it must have an accordance through nerves with the muscles of the jaws, and act in sympathy;—relax when the jaws are apart, and contract when they are closed. I think therefore we may perceive why a branch of the motor nerve of the muscles of the jaws sends a division to the muscles of the cheek and to the angle of the mouth.*

By such a process of reasoning, we see also why a branch of the same nerve should prolong its course under the chin to the muscles which are opponents to those which close the jaw.

---

* In defect of the portio dura the lips are checked; in defect of the fifth the cheek.

In short, the motor portion of the fifth nerve sends no twigs with the ophthalmic division, nor with the superior maxillary nerve, but only with the lower maxillary nerve. To the muscles of the lower jaw alone which are in action during mastication, and to the muscles necessarily associated in that action, the manducatory nerve is distributed.

It remains only that we observe what takes place in man, and compare the circumstances with experiments on brutes.

I was consulted in the case of a lady with an uncommon disease in the side of the head: the description of her condition puzzled me very much; there was so much said of tumours with pulsation on the head and face. But when I saw and examined her, the mystery disappeared; she had powerful spasms of the temporal and masseter muscles, which rose and swelled, under the excitement of a disease of the cheek, and with a pressure of the jaws so powerful as to displace the teeth. During this violent spasm of the muscles supplied by the fifth nerve, the motions of the features were free and unconstrained under the influence of the portio dura of the seventh nerve.

I have the precise counterpart to this morbid condition of the muscles of mastication in the case of a poor man now under my care. He has a disease affecting the fifth nerve of the left side, attended with loss of sensibility of the side of the face and of the surfaces of the eye. In him there is no motion of the muscles of the jaw of the affected side. In chewing, the action is only on the right side of the head; the masseter muscle and temporal muscle of the left side do not rise or bulge out as in their natural actions; but his command over his features is perfect through the operation of the portio dura. It appears, therefore, that the disease of the fifth nerve, which has destroyed the sensibility on one side of the face, has caused a loss of motion in the muscles of the jaw on the same side.*

A more frequent occurrence establishing the distinction of motions influenced by the fifth and seventh nerves, is presented in the case of paralysis of the portio dura; for then all the muscles waste but those supplied by the fifth. In the case referred to of the man wounded by the horn of an ox, in whom the portio dura was torn, and who had the skin of his forehead, side of the nose, cheek and lips, deprived of all fleshiness and substance, and in fact wasted to mere skin, the muscles of the jaw were entire and prominent; and on introducing the finger into the mouth and making him imitate the motions of mastication, a weak contraction could be felt in the cheek.†

These facts close the evidence of the fifth nerve being a double nerve; not only the nerve of sensibility to the head and face, but a muscular nerve to the muscles of the jaws, active in mastication, and otherwise useful in all animals whose jaws are prehensile and used as hands. This curious fact, originally drawn from the anatomy and now confirmed by it, had nearly been obscured by experiment; since the external branches of the fifth nerve, those most exposed to the experimenter, are not muscular.

I acknowledge here the correction of M. Magendie, in regard to the office of the suborbital division of this nerve, since it has given occasion to the revisal of the anatomy.*

---

* This patient died; and on dissection, it was found that the nerve was destroyed near its root, and the manducatory muscles were pale, thin, and tendinous, whilst the muscles supplied by the portio dura were natural.

† How often a question has occurred as to this motion in the cheeks, may be seen on referring to the Cases in the Appendix.

We were involved in great confusion by the discovery of new branches of nerves and of ganglions, through which we had no guide, until we formed a correct arrangement of the whole system. It is satisfactory to find that the ideas first suggested by a comparison between the roots of the nerves and their complex distribution in the face and neck are correct, when tried by a minute investigation of the internal nerves of the head; and that the conclusions drawn from the anatomy are confirmed both by experiment and by a knowledge of the effects of injuries and of disease in the human frame.

Additional Note.—As the most important fact in this paper is that ascertained by experiments on the fifth nerve, I am bound to say by whom they were made, and for what purpose.

To my late brother-in-law, Mr John Shaw, whom I educated, I have been indebted through the whole of this inquiry. He had long been acquainted in the most intimate manner with my pursuits. He had repeated my experiments on the roots of the spinal nerves, confirming the results—that the anterior roots when irritated caused the muscles to contract, and that the posterior roots had no such influence.

He assisted me in my experiments on the nerves of the face, which were for the purpose of establishing that the fifth pair resembled the nerves of the spine, and at the same time proving, what was incomplete from the experiments on the spinal nerves, that a ganglion on one of the roots of a nerve is no cause of interruption to sensation, but the sign that it bestows sensibility; making certain what could be only assumed from the experiments on the spinal nerves.

---

* M. Magendie says, "Le résultat que nous avons obtenu s'accorde parfaitement avec celui que nous venons de rapporter, à l'exception toutefois de l'influence de la section de sous-orbitaire sur la mastication, influence qui n'a pas éte evidente pour moi."—*Journal de Physiologie*, 1821.

But he was acquainted also with my opinions drawn from the distribution of the nerves in the body contrasted with the anatomy of their roots. And when the correctness of these opinions was established by experiment, he let no opportunity pass of advocating and supporting them. In collecting information and making dissections he was ever active, as all the real students educated with him will testify. It was in the fervour of his zeal that he went to Paris and explained the arrangement by which I distinguished the nerves; and repeated my experiments with M. Magendie and others at Charenton near Paris in 1821.

At this time an idea was thrown out that the fifth nerve was not for mastication, and that it was no more than the sensitive nerve of the face accidentally separated from the muscular nerve (the portio dura). Perceiving that if this notion prevailed we should be thrown back into our former state of confusion, Mr Shaw, in order to put the matter beyond all question, performed those experiments which are contained in this paper,—experiments which, in the gentleness of his nature, he would have hesitated to make from their severity, but for their being imperatively called for.

Had Mr Shaw lived, this subject would have been further advanced. Whilst his excellent judgment and indefatigable exertions aided me in every difficulty, his gratification in witnessing the progress of these inquiries was a reward beyond what I have now to look for.

ON THE NERVES

WHICH

ASSOCIATE THE MUSCLES OF THE CHEST, IN THE ACTIONS OF BREATHING, SPEAKING, AND EXPRESSION.

ON THE NERVES OF RESPIRATION.

Read before the Royal Society, May 2. 1822. *With Additions.*[*]

THE following paper contains an exposition of the nerves of respiration; their peculiarities, drawn from anatomy; their distinguishing properties, physiologically considered; and their morbid conditions. It is a subject of some difficulty, because the anatomy is intricate; and this, I suppose, is the reason why there are some who comprehend the distinctions made in the spinal nerves, and the difference in function of the nerves of the face, but do not venture to hold an opinion on this more difficult subject. I regret this; for it is here that we have the practical benefit arising from a knowledge of the different systems of nerves. It is the knowledge of the nerves of respiration distributed on the neck, throat, and thorax, that will enlighten the physician in distinguishing symptoms of disease.

---

[*] I have added more freely to this paper than to the former. I have felt disappointment that so great a subject, so full of interest, and so useful in practice, should have made so little progress; and under the idea that there must have been something obscure in the writing, I have attempted to improve it. I introduced this subject early, conceiving it to be highly interesting. But it has been long of exciting attention, in so much that it was not till twelve years after the original publication, that the subject was prosecuted during the meeting of the Scientific Association at Edinburgh.

OF RESPIRATION.

On the Action of the Chest, Neck, and Face, in Respiration; of the Nerves which combine these parts and control their actions; and of the Offices performed by these Organs of Respiration, in subservience to other purposes than the conversion of Venous into Arterial Blood.

The term respiration gives rise to no other idea in the mind of the physiologist, than of certain chemical changes wrought in the lungs. What, says a very eminent philosopher, is the meaning of speaking of the respiratory nerve of the face? what has the face to do with respiration? The meaning of applying the term respiratory nerve of the face is, that such a question might be asked; and that we should be brought to consider the action of respiration in a better and truer sense, than as limited to its influence on the blood; that we may have our minds opened to the interesting spectacle which is to be exhibited in this paper; and that we may perceive, and learn to appreciate, the marvellous combination of parts, by which breathing, voice, speech, and expression, besides smelling, coughing, sneezing, vomiting, are accomplished: in short, that there is such a combination as ministers not only to the vital act of decarbonizing the blood, but to the higher properties of mind, as well as to a number of lesser actions necessary to our very existence.

Let us suppose that Nature were as improvident as we may have conceived her to be; that the act of dilating and compressing the chest were sufficient to the act of respiration; how is the air to find admission through the long, membranous, and compressible tubes which communicate between the lungs and the atmosphere? Just as it does in an apoplectic man; the lips would move like valves flapping in the stream of air; the nostrils would be collapsed when they should be expanded; the velum pendulum palati would fall down upon the passage; the muscles of the glottis would be relaxed, and, instead of the variety of sounds and articulate language which result from the accommodation of these muscles to those of respiration, there would issue no sound but the snoring, or stertorous breathing, as in an apoplectic person.

Let us examine these points one by one.

1. I have at present a patient paralytic on one side of the face; when he draws his breath this nostril is drawn together; almost shut at the instant when it should be expanded: and to breathe in excited respiration he must breathe through his mouth.*

2. If we are looking into a patient's throat, what do we say to make him draw up the palate, that we may see into the fauces? do we tell him to draw up his uvula? Even if he knew what we meant, he has no direct power over the motions of that part. We tell him to draw his breath, and in this action we see the uvula and velum retracted, and the passage widened. And so it happens that, as nature has connected the nostril with the motion of inspiration, and the orifice of the tube expands according to the necessity for inspiring air, in the same manner the fleshy curtain which hangs in the fauces is furled up during inspiration through the mouth.

3. At the same time that these motions of the nostril and fauces take place, the chink of the glottis opens at each inspiration, as I think was first noticed by Le Gallois, and which I have also witnessed.† The glottis,

---

* See the Appendix.

† In a rabbit dying under the experiment of dividing the spinal marrow below the roots of the respiratory nerves, and insensible: whilst the

pharynx, and nostrils, must expand in proportion to the call for free inspirations; and without this our condition would be worse than that of the asthmatic; we should be suffocated. It will be presently shown how much further the sympathies of the act of respiration extend; but these facts sufficiently evince that there must be a wide-spreading means of connexion between parts that are remote, to provide for freedom in the simple act of breathing, independently of those accessory operations performed though the apparatus of respiration for other objects than the oxygenation of the blood. We shall take an illustration from the breathing of a horse. The horse does not breathe by the mouth, but only through the nostrils; therefore those tubes are formed of large moveable cartilages, which expand under the influence of appropriate muscles. When a horse has run his stage, the motions of his flanks, his sides, his neck, and nostrils, exhibit a degree of excited action, which corresponds with the accelerated state of the circulation, and the sweat that pours down from him. This inflation of his nostril, and the outstretched position of his head, exhibit the necessity of the air-tube being made free and capacious, in proportion to the increased quantity of air drawn in and sent forth in respiration; and the exact correspondence of the motion of the nostrils with the sides shews the necessity of nervous cords of connexion between parts so nearly related in function, al-

diaphragm and muscles of the neck and of the nose moved in regular succession, I opened the larynx. At this time the glottis was supplied by the laryngeal nerve of the left side only. Having made a section of the cartilages of the larynx, I saw that at each inspiration the crico-arytenoideus and thyro-arytenoideus muscles drew aside the arytenoid cartilage, performing a motion exactly corresponding with the dilatation of the nostril; that is, expanding the glottis, to enlarge the passage for the more free inspiration.

though so remotely situated. Accordingly, if you ask an intelligent jockey what are the points of a horse for the turf, after speaking of the strength of the loins, the height of the hind quarters, the shortness of the bones from the hock to the hoof, he will speak of the large nostril, the broad full windpipe, and the deep chest; because his experience has shewn him that good lungs are accompanied with a free and capacious tube for the entrance and egress of the air in respiration. He sees, what I wish to inculcate, that the organs of respiration are not confined to the lungs, but extend to all the parts necessary to the free play of the air through the passages in excited respiration.

Before I proceed to the formal consideration of this subject, I shall refer the reader to a comparative view of these nerves. We have traced the nervous system in the lower animals, and we have seen that the regular ganglionic system of animals of the lower class is sufficient for sensibility, for voluntary motion, for the power of prehension and mastication of the food. But that call which gives occasion to inspiration is quite unlike pain from external impression, as the act it excites is unlike voluntary motion. It is an instinctive impulse, powerful in the moment of birth as at any after period, which calls the respiratory muscles into action; and the motion it produces is of that instinctive or automatic kind, which is perfect from the beginning.

A new-sense, and a new concatenation of motions, require a new nerve, a distinct centre or origin, and a new apparatus of muscles. In the inferior creatures, with a system of air-tubes carried through the body, no muscles of respiration were necessary: But when a creature higher in the scale is endowed with concentrated organs of respiration, and when to move these (which are passive in themselves) there are appropriate muscles given, what will those muscles avail if there are not also new nerves appropriated to them? They must be placed under the control of a power which would have been superfluous and useless in the animal which had no lungs: There are no other means of relationship between this new power and these new muscles than by nerves; and these must be *respiratory* nerves.

We perceive, therefore, how it happens that—in tracing animals upwards from their simplest to their more complex organization, with each new organ, and with every acquisition of new muscles—there must be additional nerves appropriated to them.

A question has been agitated—Whether the act of respiration is a voluntary or an involuntary action? and, strange to say, some have determined that the action which proceeds so equably during sleep, which is uninterrupted in the insensibility of apoplexy, which continues when the head of an animal is crushed, the brain deeply injured, or the head altogether removed, is an act of volition, depending upon the impression made on the sensorium. When during the painful duty of a physician attending the bed of a dying person, he sees all sensibility fall low, and volition lost, yet how powerfully the chest and shoulders rise, and the flanks are drawn, can he say that this arises from a more powerful impression on the sensorium?

Nothing but a cherished hypothesis could bring a person to this conclusion, against the hourly and obvious concurrence of facts. The confusion, for such I presume there is, arises from the real difficulty of accounting for the respiratory system becoming an instrument under the influence of the will. We must distinguish from the act of volition that state of the breathing which corresponds with the state of the pulse: that condition of the system by which the air is drawn and the pulse beats with exact correspondence. We have no power to disturb the established relation between the circulation and the respiration; these are conditions of the vital functions too important to be left to the influence of the will. The power of volition over the breathing is of a different kind altogether; it is occasional or temporary, and is permitted only so far as becomes necessary to make the apparatus of respiration subservient to other offices.

We can distend the chest by an effort of the will; and we can force the air out in bellowing, but in doing so there is an obvious interference with the respiration through additional voluntary muscles. In observing the manner in which we command the breathing in this interference, we shall better comprehend the importance of the class of nerves I am to point out. It is by closing or opening the air-tubes; by playing, as it were, on the ventiges, as in fingering a wind-instrument of music.

Thus, we can close the glottis by the laryngeal muscles, and suspend the breathing for a short time. If there be no effort of the will, we breathe through the mouth and the nose equally: But we can breathe without smelling, and draw the air through the mouth without drawing it through the nose; or blow with the nose without the air coming through the mouth. And all these are irregular, partial, and temporary interferences with the act of respiration. When the act of respiration, considered in its highest office—as subservient to the oxygenation of the blood, is temporarily stopped, an accurate account of this interruption is kept, and we must pant and breathe hard to make up for the time lost, or for the function having been so far obstructed, by this interference of the will. If all these circumstances be neglected in our course of reasoning, then, to be sure, we may say that respiration is a voluntary act, because we can blow out a candle!

Physiologists enter freely on these inquiries, if they forget the anatomy of the nervous system; but if they were discoursing over the dissection of the nerves of the neck and thorax, I apprehend there would be some embarrassment. To us, the inquiry still shapes itself thus: —What is the meaning of this extraordinary concourse of nerves to these parts?

We shall find no clew to the intricacy of the nerves of neck and thorax, unless we carefully consider the actions of the muscles of the neck and chest.

There are two distinct conditions of the respiratory organs. *First,* That play of the chest, soft and equable, necessary to the expansion of the lungs and the inhalation of the atmosphere. *Secondly,* A condition of more powerful exertion, in which another class of muscles comes into action, and the chest rises high and the breathing is hurried.

The first of these conditions corresponds with the state of the circulation, in which the lungs act in their primary character, as the instrument of oxygenating the blood (as the term is still used). The second is a more animated condition, and has some other end in the economy: bodily exertion or passion may be the cause of excitement, or voice and speech may be the purpose of it.

For this second condition, in which a new object is to be attained, different altogether from the original office of the lungs, there are provided appropriate muscles and nerves. We must continue to call these, parts of the apparatus for breathing, because it is upon the air that they operate; but they more properly belong to the actions of speaking, smelling, and expression—of laughing, sneezing, and vomiting: actions which are either necessary to safety in the complicated organization, or by which new and essential powers of action are developed, distinct from the original office of the lungs.

All these different offices, performed by the organs superadded to the lungs, must be studied, if we hope to explain why there is so great a concourse of nerves to the neck and chest. It is even more necessary to consider the functions of the parts with reference to the nerves of the throat, tongue, neck, and chest, than it is to study the functions performed in the face, in order to enable us to detect the distinct offices of the nerves there.

OF THE MUSCLES OF THE TRUNK, WHICH ARE BROUGHT IN AID OF THE COMMON RESPIRATORY MUSCLES.

If we look upon the frame of the body for the purpose of determining which are the muscles best calculated to assist in the motions of the chest when there is an increased or excited action, we shall have little difficulty in distinguishing them; and we shall have as little hesitation in assigning a use to the nerves which supply those muscles exclusively.

These muscles, in effect, we see powerfully influenced in deep inspiration, however excited. They are the mastoid muscle, the trapezius, the serratus magnus, and the diaphragm. They operate in a circle, and all would be useless in the act of respiration were one to be wanting. The serratus magnus, as every student knows, expands the ribs; but this it does only when the scapula, to which it is attached, is fixed; and unless the scapula be fixed this muscle has no operation in breathing. The trapezius fixes the scapula by drawing it backwards and upwards. These two muscles must always correspond in action, in order to expand the chest. Now, let us see how the trapezius influences the operation of the sterno-cleido-mastoideus. The mastoid muscle elevates the sternum; but only when the head is fixed, which is done by the action of the trapezius on the back of the head and neck. To this train of connexions we may join the diaphragm itself, since, without the action of the serratus, the margins of the thorax would sink in by the action of the diaphragm, and the force of that muscle would be consequently lost. Let us attend more particularly to the exterior class of muscles.

1. *Sterno-cleido-mastoideus.*—This muscle, by its attachment to the sternum or breast-bone, and to the clavicle, raises or heaves the chest. In the usual description of the muscle it is considered as a muscle of the head, the lower attachments being the *origins;* but when the head is fixed it becomes a muscle to raise the chest, and its operation is very evident in all excited states of respiration; in speaking, and still more in singing, coughing, and sneezing. But there is something necessary to the full effect of this muscle on the chest, for otherwise it will be a muscle of the head, and not of the chest. This leads us to the next muscle.

2. The *trapezius* must fix the head or pull it backwards before the *mastoideus* can act as a respiratory muscle; and how they are combined we shall presently see. The position of the head of the asthmatic, during the fit, as well as the posture of the wounded or the dying, prove the influence of the upper part of the trapezius in excited respiration: that is to say, when the shoulders are fixed, this muscle, usually described as a muscle of the superior extremity, becomes a muscle fixing the head.

The trapezius has a still more powerful and important influence in respiration when the action rises above the ordinary condition, and that is by drawing back the scapula and elevating it, to give the necessary effect to the action of the serratus magnus on the ribs.

3. The *serratus magnus anticus* being extended over the whole side of the chest, and attached in all the extent from the second to the eighth rib, is very powerful in raising the ribs and holding out the margins of the chest, which would otherwise be drawn in by the diaphragm: and to this effect the intercostal muscles alone would be insufficient in the high or excited state of respiration. But it cannot exert this power independently of the trapezius, since, without the combination explained above, its force would be exerted in its more common office of moving the scapula, and not the ribs. Unless the scapula be fixed, or pulled back by the *trapezius*, the *serratus* is not a muscle of respiration.

In this manner do these three powerful muscles hold together in their action, combining with the diaphragm to enlarge the cavity of the chest in all its diameters. These external muscles do not interfere with the gentle actions of breathing. But if the apparatus of respiration is to be employed in any excess of action, in passion, in dying, in speaking, singing, coughing, yawning, &c., these become powerful instruments. Let us observe how necessary the muscles of the neck are to respiration and circulation.

THE ACTION OF THE MUSCLES OF THE NECK SHEWN TO BE NECESSARY BOTH FOR RESPIRATION AND CIRCULATION.

In the muscles of the neck, we have a subject which has been entirely overlooked. The admirable work of

Albinus, and the various little works on dissection, have not left the fibre of a muscle undescribed; and this accurate anatomy has given rise to the notion, that the knowledge of the muscles is complete. On the contrary, Albinus, Cooper, Innes, &c., give us the mere rudiments of knowledge: from their description of the origin and insertion of insulated muscles, we understand nothing of the combined action of muscles, or of their relation to important functions. In this state of ignorance of muscular action, what can we comprehend of the nerves distributed on the side of the neck? To go fully into this inquiry, we should not only have to consider the action of respiration, but the principles of hydrostatics and pneumatics, as they illustrate the effect of respiration on the circulation. We must here be satisfied with remarking, that when the sterno-cleido-mastoideus muscle lifts the sternum and clavicle in inspiration, it takes off pressure from the great veins of the neck, so that the blood from the head descends freely at this time; when the thorax descends again, these veins are compressed; and in this manner does the act of respiration assist the circulation through the head.

The platysma myoides is a muscle of respiration, and acts in aid of the mastoideus; not only assisting it in all conditions of excited respiration, but acting in a more particular manner, in alternately taking off the pressure from the veins of the neck, and again compressing them and urging the blood into the heart. In short, the muscles of the neck rise at the same time that the thorax is raised and expanded; and the alternate rising and falling of the platysma myoides and sterno-cleido-mastoideus are essential accompaniments of the high or excited act of respiration. It is strange that so important a part of the mechanism of the frame should have been neglected so long. We notice it now because it is essential to the knowledge of the nerves of the neck.

We are thus brought to comprehend the necessity of a combination being established between these muscles, forming the exterior layer on the breast, back, and neck. How interesting, then, to find that there are nerves coming from a part of the medulla oblongata (the precise part which is proved to hold a control over the actions of respiration), and that these nerves accumulated in a narrow space at their origins do in fact diverge and expand out on these muscles, and on these muscles only! With what interest, I say, must we perceive, that these muscles so commonly combined in action, so necessary to each other, and which are abundantly supplied with nerves of sensation and volition, have respiratory nerves in addition distributed to them!

The proofs of the existence of such a class of nerves will presently appear. But for a moment let us take it for granted, and let us ask, with what nerves these additional respiratory nerves should be joined? We have understood that these muscles, and these nerves, are bestowed for the purpose of bringing the respiratory organs in aid of ulterior objects: those objects are, amongst others, natural sounds, articulate language, and expression: respiration, which is a function originally limited to the exposure of the circulating blood to the atmosphere, is to become employed in operations which regard the development of the powers of the mind itself. We have just examined this superadded apparatus of muscles and nerves, and we comprehend their object. Is it not, then, with the nose and lips, and fauces and larynx, that these nerves must be joined? Accordingly we find that the nerves going to the diaphragm, larynx, pharynx, lips, and face, are associated with these, and diverge from the same source.

ORIGINS OF THE RESPIRATORY NERVES.

The nerves on which the associated actions of voluntary and excited respiration depend, arise very nearly together. Their origins are not in a bundle, or fasciculus, but in a line or series, and from a distinct column of the spinal marrow. Behind the *corpus olivare* there is a portion of the medulla which belongs neither to the motor nor to the sensitive tracts, and which on dissection will be found to have more direct connection with the *corpus restiforme*. This fasciculus, or *virga*, may be traced down the spinal marrow, between the sulci, which give rise to the anterior and posterior roots of the spinal nerves.

This portion of medullary matter is narrow above, where the *pons Varolii* overhangs it. It expands as it descends; opposite to the lower part of the *corpus olivare* it has reached its utmost convexity, after which it contracts a little, and is continued down the spinal marrow less distinctly pronounced.

From this tract of medullary matter on the side of the *medulla oblongata*, arise in succession, from above downwards, the *portio dura* of the seventh nerve; the *glossopharyngeus* nerve; the nerve of the *par vagum;* the *nervus ad par vagum accessorius;* and, as I imagine, the *phrenic* and the *external* respiratory nerves.

A question may be here touched upon, which, however, does not affect the main reasoning. Does this column of the *medulla oblongata* continue down the whole length of the *medulla spinalis?*

It is probable that the branches of the intercostal and lumbar nerves, which influence the intercostal muscles and the muscles of the abdomen in the act of respiration, are derived from the continuation of the same cord or slip of medullary matter; and the nerves called phrenic and external respiratory, though coming out with the cervical nerves, may in all probability take their origin from the same tract or column of the spinal marrow.

Before we trace these nerves to their destinations, let us pay some attention to the part of the spinal column from which they originate.

It has been stated that I began my researches where M. le Gallois * left his imperfect. This is not quite correct, since my inquiries were instituted long before I was acquainted with M. le Gallois's just celebrity; but I had confirmation of my opinion in his experiments, and felt more confident that I was proceeding in a proper course. M. le Gallois had said, and the observation was confirmed in the paper of Mr Lawrence,† that whatever part of the brain was wanting in the acephalous child, if the origin of the eighth pair was entire, the child would respire. On the other hand, my own experiments, and my experience in witnessing the effects of injuries of the spine, had taught me that, notwithstanding an injury of the spinal marrow opposite to the fifth vertebra of the neck, the individual might breathe and live.

The principal seat of the power which controls the actions of respiration was thus indicated to lie within a very narrow compass; and the conclusion so far deduced is confirmed by abundant evidence, that if the part indicated

---

* Nous voici donc arrivé au point d'où M. Charles Bell a parti, et ce point est précisément celui où mon père s'était arreté en le signalant à l'attention des physiologistes.—*Eug. Le Gallois.*

† Medico-Chirurgical Transactions. See also the Appendix.

be crushed, respiration stops in the instant, and death ensues without even a momentary struggle.

We have arrived at that point of the inquiry, when, with some hope of a satisfactory answer, we may require an explanation of the extraordinary intricacy of the nerves of the neck, throat, and chest.

On the side of the neck we see the *portio dura* sending down a division to the exterior cervical plexus; we see joined in the same superficial distribution of nerves the second, third, and fourth cervical nerves, the roots of the phrenic, and the branches of the ninth nerve. Deeper we find the spinal accessory, the glosso-pharyngeal nerve, the laryngeal and pharyngeal divisions of the eighth, and the recurrent, the trunk of the ninth, and the gustatory of the fifth. Every dissector deserving the name of student of anatomy has stood astonished and confounded at this display.

We proceed to unravel this confusion: and for this purpose we must return to the anatomy of the *medulla oblongata*, for he who holds this in his hand has the key to the nervous system.

The *nervus vagus* arises by many distinct feet from that column of nervous matter which is between the motor and sensitive columns, in a manner very different from the roots of the spinal nerves, and from a point quite distinct from the ninth or *lingualis*. Passing out by the *foramen lacerum* in the base of the cranium, it travels extensively, supplying the pharynx, larynx, and lungs, and then by the side of the œsophagus passes into the abdomen, to be given to the stomach principally, and is ultimately lost in the solar plexus. That this is a nerve distinct in every respect from the class of voluntary and sensitive nerves, must be universally admitted; and in addition to all that has been delivered by old authors, late experimenters have found that by the irritation of the nervus vagus convulsive acts of inspiration are excited.

By reference to any common book of anatomy, the phrenic nerve will be found to have its great root or origin from the fourth cervical nerve; and to this is joined a more slender branch from the third cervical nerve. But, besides these roots, it has connexions which of themselves would mark the relations of the nerves. High in the neck, it is connected with the *nervus vagus* and with the *lingualis* or ninth, while, at the same time, a branch is given off to the muscles of the larynx. The trunk of the nerve descends into the cavity of the thorax, and gives no branches, until, arriving at the diaphragm, it sends out numerous diverging branches, which are lost in the substance of that muscle.*

It has been long known that irritation of this nerve convulses the diaphragm, and that cutting it across paralyses that muscle. These facts, with the consideration of its course, prove it to be a respiratory nerve, and such has been the universal opinion.

But to what purpose should a distinct nerve be sent to the diaphragm, if the other muscles, seated externally, and which are associated in action with the diaphragm, and as important to respiration, were left without a similar tie to unite them with each other, and with the organs of the voice?

The *inferior external respiratory nerve of the thorax* is a counterpart of the internal or phrenic nerve. It comes out from the fourth and fifth cervical nerves, and often it is connected with the phrenic. It diverges somewhat from that nerve, because, instead of descending within the chest, it falls over the ribs, and descends in a distinct flat trunk upon the outside of the chest, to be distributed entirely to the *serratus magnus anticus*. This muscle has nerves from the spinal marrow, because it has to combine in the motions of the frame in locomotion. But the long descending nerve is a respiratory nerve; which we may know from its origin, course, and destination. In its origin and course it is like the diaphragmatic nerve; it passes across the common spinal nerves without joining them; and in its destination also it resembles the phrenic, since it is given to a muscle necessary to full inspiration.

---

* Among the desiderata which I was wont to propose to the students were the questions,—"What are the branches of the spinal nerves which enter into the composition of the eighth pair? and, What are the branches of the phrenic to the scaleni? Any? or None?"

I come now to the *spinal accessory nerve*,* which is more particularly an object of interest in this paper. It is called here the superior respiratory nerve of the trunk. Experiments may take a colour from the preconceived idea, but the accurate investigation of the structure will not deceive us. I therefore entreat attention to the anatomy of this nerve, as leading in the most conclusive manner to a knowledge of its functions.

It arises from the cervical portion of the spinal marrow; but instead of collecting its branches to go out by the side of the vertebræ, like the internal and external respiratory nerves, it shoots upwards within the theca of the spinal marrow, enters the skull, and joins the eighth pair of nerves; from which it has its name of Accessory. We see the roots of this nerve as far down as the fourth cervical nerve.† These roots arise neither from the posterior nor from the anterior column of the spinal marrow; but between the posterior roots of the cervical nerves and the *ligamentum denticulatum,* and from the *column of medullary matter* above described as the respiratory column. The origins of this nerve come off in one line, and that line is in the direction of the roots of the glosso-pharyngeal and par vagum, and of that nerve which has been proved to be the respiratory nerve of the face, the *portio dura* of the seventh. In its ascent the accessory nerve is attached to the posterior root of the first cervical nerve.

---

* *Nervus ad par vagum accessorius.*

† In the ass, its roots are seen to extend much lower down.

The nerve having ascended through the *foramen magnum,* passes out from the skull associated with the nerves which constitute the *eighth pair,* and in the same sheath with them; they all go out through the *foramen lacerum,* and by the side of the jugular vein. In this course the accessory nerve divides into two. One of these divisions joins filaments of the *par vagum;* and these, again, send nerves to the *glosso-pharyngeal* nerve, and sometimes a branch may be seen going to the *lingualis* or ninth. The more external division of the accessory nerve descends behind the jugular vein, and comes forward and perforates the mastoid muscle. In its passage through the muscle it sends off branches which take their course through its substance; and if, as sometimes happens, though rarely, the nerve does not pass through the muscle, these branches, notwithstanding, are invariably given to it.

When the nerve has escaped from the back part of the mastoid muscle, it forms a communication with that branch of the third cervical nerve which ascends behind the muscle; and nearly at the same time it is joined by a branch from the second cervical nerve. The superior respiratory nerve now descends upon the neck, and begins to disperse its branches in regular order to the edge of the trapezius muscle; four or five branches take their course to that muscle, separate into minute subdivisions, and are lost in its substance. One more considerable division, being the lowest of these, is joined by a long descending branch of the second cervical nerve. Increased by this addition, it descends under the trapezius and behind the clavicle. Following this descending branch, it will be found exclusively attached to the trapezius. Behind the scapula it is again joined by branches from the spinal nerves; and here a sort of imperfect plexus is formed, from which divisions of the nerve, still descending, follow the lower edge of the muscle, and are finally dispersed among its fibres.

This nerve arises from the same column with the respiratory nerves; it takes a most intricate and circuitous passage to form a junction with nerves which we know to belong to that class; it sends branches to join the nerves of the tongue and pharynx; it sends branches to the larynx in company with the branches of the *par vagum*; it then crosses the great nerves of the neck, passes under the spinal nerves, goes to no other muscles in its course, but lavishes all its branches on the mastoid and trapezius muscles. To an anatomist it is as plainly set forth as if it were written in our mother-tongue—this is *the superior respiratory nerve of the trunk.*[*]

The following experiments were made on this external respiratory nerve by Dr Marshall Hall, Mr Broughton, assisted by Mr Field the veterinary surgeon:[†] "This nerve being pricked without any response, was then slightly pinched and scraped, when the sterno-maxillaris muscle, the levator humeri, and other muscles of the neck exclusively were seen to contract at each application of this mechanical irritation. But when the forceps were applied firmly, and continued a few moments, similar effects were produced as with the vagus and the seventh. The branches of this nerve appear to be equally destitute of sensibility with the root." *

---

[*] *Lobstein*, in a dissertation on this nerve, finding the difficulty of accounting for the *nervous fluid* coming by a double passage to the muscle, concludes, "*veniet forsan tempus, quo ista, quæ nunc latent, dies extrahat et longioris ævi diligentia.*"

[†] On the Horse and Ass.

COMPARATIVE VIEW OF THESE NERVES.

If we examine the *par vagum*, the *portio dura* of the face, the *external thoracic*, the *diaphragmatic*, and the *spinal accessory* nerves, in comparative anatomy, we shall conclude that they are all respiratory nerves, by their accommodating themselves to the form and play of the organs of respiration. In fishes, the respiratory nerve † goes out from the back part of the *medulla oblongata*. When it escapes from the skull it becomes remarkably enlarged, and then disperses its branches to the branchiæ and the stomach. But from the same nerve go off branches to the muscles moving the gills and operculum, whilst a division of the nerve is prolonged under the lateral line of the body to the tail. It is said that this division sends off no branches: But this is not correct. It gives branches in regular succession to the muscles, from the shoulder to the tail. Experiments have been made upon these nerves, but their detail would lead us too far. It is scarcely necessary to add, that there are neither phrenic, nor spinal accessory, nor external thoracic nerves, in fishes; the order of their muscular system not requiring them.

---

* Fourth Report of the British Asciation for the Advancement of Science, p. 679.

† The nerve which by its subdivision supplies the heart, lungs, and stomach, and the muscles of the gills.

In birds, the structure of the wing, and the absence of the mastoid muscle, render the spinal accessory nerve unnecessary; it is wanting, for the reason that, in the absence of the diaphragm, there is no phrenic nerve. Quadrupeds have the three respiratory nerves of the trunk; but even in them there are variations in the muscular frame, which illustrate the appropriation of the nerves. The construction of the neck of the camel is like that of birds; there is a succession of short muscles along the side of the neck, and attached to the vertebræ; but there is no long muscle, like the *sterno-cleido-mastoideus*, contributing to the motion of respiration. There is, accordingly, no spinal accessory nerve in the neck of this animal.

We have a remarkable example of the manner in which these nerves vary in their course of distribution, and yet retain their appropriate functions, in the nerves of the neck of birds. In them, the bill precludes the necessity of the portio dura going forward to the nostrils and lips; the nerve turns backwards and is given to the neck and throat; and it is particularly worthy of remark, that the action of raising the feathers of the neck, as when the game-cock is facing his opponent, is taken away by the cutting of this nerve. If we compare the anatomy of the facial respiratory nerve, in the various classes of birds, we shall find its distribution to be analogous to that of the same nerve in the different tribes of quadrupeds. In the game-cock, a few branches of the nerve pass to the loose skin under the jaw, which is dilated in crowing, the greater number being distributed on the muscles of the neck, which cause the elevation of the feathers when he puts himself in an attitude for fighting. But in the duck, which, when enraged, has little or no power of expression, the same nerve is not larger than a cambric thread, and passes only to the skin under the jaw.

THE FUNCTIONS OF THESE NERVES FARTHER ILLUSTRATED.

Before having recourse to experiments on brutes, we may observe what takes place in our own bodies. By placing the hand upon the neck, we may be sensible that the mastoid muscle has two motions. The lower extremity of the muscle is fixed when we move the head ; but when we use the muscle in inspiration, the head, and consequently the upper extremity of the muscle, are fixed. Now, if we endeavour to raise the sternum through the operation of this muscle, we shall find that other muscles are, insensibly to us, brought into action, which have nothing to do with this raising of the sternum. For example, if we strain to raise the lower extremity of the muscle, we shall unavoidably produce an action of the muscles of the nostrils ; by which association of actions, we shall discover, that we are using the *mastoideus* as a respiratory muscle. If we reverse the action, and move the upper extremity of the muscle, other muscles will be drawn into co-operation, but they will be such as assist in the motion given to the head, and there will be no accompanying motion of the nostril or throat. We may vary the operation in another way. In snuffing or smelling, if we place the fingers on the portions of the mastoid muscles which are attached to the sternum, we shall find every little motion of the nostrils accompanied with corresponding actions of the sternal portions of the muscles in the neck. These facts prove that the mastoideus muscle is subject to two distinct states of association ; one in which the muscles of respiration are in action, another in which the muscles moving the head are in action.

When a man suffers fracture of the spine at the sixth cervical vertebra, and the marrow is crushed, he continues to breathe by the influence of the three nerves which arise above the injured portion. He inspires with force; but he cannot perform expiration by muscular effort; it is only by the elasticity and gravitation of the parts that the breath is propelled. He can yawn, for that is an action of drawing the breath; but he cannot sneeze, for that is an action of expelling the breath. But this is a subject so curious in itself, and which has hitherto been so little considered, that I shall reserve it for a distinct dissertation.

A man having a complete hemiplegia, the side of his face relaxed, the arm hanging down powerless, and the leg dragged in walking, we were curious to know whether the influence pervaded all the nerves of the side, or only the regular or voluntary nerves. Some trouble was taken to make him heave up the shoulder of the debilitated side, but to no purpose. He could do it only by bending the spine to the other side, and as it were weighing up the paralytic shoulder. But on setting him fairly in front, and asking him to make a full inspiration, both shoulders were elevated at the same time that both the nostrils were in motion. The respiratory nerve of the face, and the superior respiratory nerve, were entire in their office; and, although the regular system of nerves refused to act, the *sterno-mastoideus* and the *trapezius* partook of their share in the act of respiration. Seeing that the mastoid muscle has two sets of nerves; that one of these is of the class of voluntary nerves, and the other of respiratory nerves; are we not borne out in concluding, that when the head is moved, being strictly a voluntary act, it is performed through the common class of voluntary nerves? that when the chest is raised, it is an act of respiration, and is effected through those nerves which control the muscles in respiration?*

This conclusion is confirmed by the following experiment. In the ass there are two muscles which take the office of the mastoid muscle; one is inserted into the jaw, which we may call *sterno-maxillaris,* and the other into the vertebræ, viz. *sterno-vertebralis.* To these the superior respiratory nerve (or spinal accessory) is distributed in its passage to the trapezius. These muscles are at the same time supplied with numerous nerves directly from the spinal marrow. If we expose the superior respiratory nerve, and then induce excited respiration, so as to bring these muscles into powerful action in combination with the other muscles of respiration, and if, while this action is performed, we divide the nerve, the motion ceases, and the muscle remains relaxed until the animal brings it into action as a voluntary muscle.

An ass being thrown, its phrenic nerves were divided, on which a remarkable heaving of the chest took place. It rose higher, and the margins of the chest were more expanded at each inspiration. There was no particular excitement of the muscles of the neck, shoulder, or throat, at this time; so that to excite the actions of these muscles it was necessary to compress the nostrils. When they began to act with more violence, keeping time with the actions of the other muscles of respiration, the superior respiratory nerve was divided; immediately the action ceased in the muscles attached to the sternum of the side where the nerve was divided, while the corresponding muscles of the other side continued their actions.

After dividing the spinal marrow between the vertebræ of the neck, and those of the back, respiration is continued by the diaphragm: which experiment, as it is often mentioned by physiologists, the author has not thought it necessary to repeat, but only to institute the following experiment on an ass. The phrenic nerves being first divided, and then the spinal marrow cut across at the bottom of the cervical vertebræ, respiration was stopped in the chest; but there continued a catching and strong action at regular intervals in the muscles of the nostrils, face, and side of the neck. The main part of the apparatus of respiration was stopped, but these accessory muscles remained animated, and making ineffectual endeavours to perform the respiration. When apparent death had taken place, the ass was so far reanimated by artificial breathing, that the act of respiration recommenced; these muscles on the face and neck were restored to activity, and became subject to regular and successive contractions, as in excited respiration, whilst the chest remained at rest. These actions continued for a short time, and then ceased; but upon artificial respiration being again produced, the same results followed. This was repeated several times, the animal remaining insensible during these experiments, and incapable of voluntary motion.

---

* See the Appendix.

Thus it is proved, that the common muscles of respiration being cut off from the influence of respiration, and the chest and diaphragm at rest, the muscles of the face and neck remained in action, not in voluntary action, nor in convulsions of pain, but subject to the influence of respiration, and acting in regular successive impulses.

Upon stimulating the nerves after the death of this animal, it was observed, that the class of respiratory nerves retained their power of exciting their respective muscles into action, long after the other nerves had ceased to exert any power; they were evidently of that class which retain their life the longest.

I may add, that I performed these experiments long since, and I have not repeated them, resting my conviction of the accuracy of my opinion, that these are respiratory nerves, on other grounds.

I have now to make a short statement of facts. Where the phenomena have not been observed by myself, they are from the highest authorities, and the experiments were made without reference to the views now presented to the reader.

The division of the portio dura of the seventh nerve stops the motions of the nostril and of the lips, &c.

The division of the recurrent branch of the *par vagum* destroys the voice.[*]

The division of the laryngeal branch of the *par vagum* stops the consent of motion between the muscles of the *glottis* and the muscles of the chest.[†]

The injury or compression of the *par vagum* produces difficulty of breathing.[‡] When compressed by the forceps, it causes a respiratory effort, or an act of deglutition accompanied with a cough and struggle. When this nerve was divided, and the upper cut end irritated, the same effects were produced as when the nerve was irritated in its entire state.

don't see why.

The cutting of the phrenic nerve stops the motion of the diaphragm.

The division of the spinal accessory nerve stops the respiratory motion of the mastoid and trapezius muscles. When the nerve is irritated by compression, convulsive action is excited in the apparatus of respiration.

---

[*] Sectis ambobus nervis recurrentibus vox perit.—*Arnemann, Söemmerring, Morgagni.*

[†] *Le Gallois.*

[‡] Vinculo compressis nervis vagis oriuntur in bestiis spirandi difficultas, surditas, vomitus, corruptio ciborum in ventriculo.—*Söemmerring, Haller, Brun de Ligaturis Nervorum.*

Thus, we complete the knowledge of the circle of actions which result from the respiratory nerves, and which are necessary to breathing. By attending to the respiratory organs, we may cut off the system of the irregular nerves, although we leave the regular nerves perfect. The regular system of nerves, those common to all animals, do not minister to these actions of respiration in the face, throat, and neck.

The *medulla oblongata* and *spinalis* are composed of columns of nervous matter: and from the different powers of the nerves arising from the one or other of these columns, it is proved that they possess distinct properties. In animals that breathe by ribs and a numerous class of muscles, and which animals have a spinal marrow, we see that a column of nervous matter is embraced between the anterior and posterior *virgæ* of that body, and that this portion may be traced downwards between the roots of the spinal nerves. From the upper part of this column, where it begins in the *medulla oblongata*, the several nerves proceed which have been just described, and on the influence of which, it has been proved, the motions of respiration principally depend. It is not an extravagant conclusion to say, farther, that the power of the regular series of intercostal and lumbar nerves, as far as they regulate the respiratory actions, proceeds from the connexions of the roots of these nerves with this column, which is continued downwards, and which can throughout be distinguished from the rest of the spinal marrow.

We are now enabled to distinguish the influence of the spinal marrow, and its regular succession of nerves, from those which have been called respiratory. The first are essential to the act of respiration; without them the others are unequal to the task. But, on the other hand, although the regular succession of spinal nerves be equal to the raising and depressing of the thorax, they are not equal to the full heaving of the chest as in inanimated exertion of the voice. They are not competent to the performance of the motions of the glottis, pharynx, lips, and nostrils, which several parts are necessarily influenced in excited respiration, as well as in the acts of smelling, coughing, sneezing, and speaking: for these, the co-operation of the whole extended class of respiratory nerves is required.

Now we comprehend the difference between the effects of injuring the medulla oblongata, and cutting the *par vagum*. In bruising the first, we at once destroy the motions of the nostrils, larynx, pharynx, glottis, the neck, shoulders, and diaphragm. Who will doubt, that, if nerves going to all these parts were simultaneously divided, immediate death would result?*

OF THE SEAT OF THAT POWER WHICH CONTROLS THE RESPIRATORY MOTIONS.

The perfect sympathy which combines the muscles in the act of respiration—muscles seated in parts of the body remote from each other—would imply some common centre from which the power emanates. If our inquiry be directed by the anatomy, we shall not be long of discovering the seat of this influence. It is not in the brain, because animals breathe when both cerebrum and cerebellum are removed. It cannot be in all the spinal marrow, because if the spinal marrow be divided three fingers' breadth from the upper part of the column, the person breathes through the nerves which arise above the division, although not at all by those which arise below. On the other hand, it is familiarly known, that if the medulla oblongata be crushed, all actions connected with breathing cease in the instant. Here, then, must be the seat of that power which controls the motions of the nostrils, pharynx, fauces, larynx, diaphragm, and shoulders, by that class of nerves which we have pointed out as diverging from this point, and have called respiratory.

---

* These respiratory nerves of the thorax, the diaphragmatic, the spinal accessory, and the external thoracic nerve, are all nerves of *inspiration*. The act of inspiration is provided for in a more especial manner than the act of expiration. It requires more muscular effort, and is more essential to life. Inspiration is the first act of resuscitated life, the last of exhausted nature, and for this reason the muscles of inspiration are large and powerful, and the nerves in a double order; for not only do the lateral branches of the spinal marrow influence the act of inspiration, but these additional respiratory nerves descend from the upper part of the spinal marrow to the chest, as an additional and especial provision, guarding life.

Some modern inquirers have thought to extricate themselves from the difficulties of their subject, by ingeniously arguing that respiration is a voluntary action—that is, that a painful impression attends the cessation of breathing; that the impression is conveyed to the sensorium, and from the sensorium the will acts to make us draw breath. If we say that this action goes on in sleep, so, they will tell us, an irksome posture makes us turn in bed while asleep; but I know not how they explain the respiration in apoplexy, far less how it can be supposed possible that respiration proceeds from a sensorial impression, when it is known from undoubted authority that an animal continues to breathe after both cerebrum and cerebellum have been dug out of its skull.

We, therefore, confidently return to our position, that the medulla oblongata is the seat of that power which gives motion to the parts in respiration. But, are we correct when we say that we draw breath under the sensation of oppression in the chest? The belief is very natural that the condition of the heart and lungs draws after it the action of the muscles in inspiration. But is this opinion consistent with the following facts?—The spinal marrow is divided below the medulla oblongata; the animal continues to breathe: the two nerves of the par vagum are divided; the nostril continues to move, the animal gasps, the chink of the glottis opens and closes, the larynx is drawn down, the diaphragm acts; all these actions are simultaneous; they follow in regular succession as in common breathing, and in this condition the animal will live some time. Here there can be no communication of sensations from the heart and lungs; all the nerves are cut but those which go out from the medulla oblongata to the parts moving. The conclusion, therefore, I must presume is, that in the lateral portion of the medulla oblongata, from which the several respiratory nerves go off, there is seated a power which, passing out through these diverging nerves, combines the remote organs.

I know not how further to avoid the conclusion that the regular succession of actions in respiration is directly consequent upon the influence of this part of the nervous system.* It is incomprehensible, certainly, but not more so than the effect of volition. Whilst the brain presides over the various voluntary movements, controlling an infinite variety of combinations of muscles in the familiar actions of the body and limbs, this portion has a power of influencing certain muscles; but with this difference—that the arrangement of muscles in their action is always the same, and the action after regular periods of intermission.

---

* I may here add a conjecture on the provision for securing the circulation through a part so vital as the *medulla oblongata*. The vertebral arteries are supposed to run in the canal of the cervical vertebræ to secure the circulation in the brain, in the event of compression on the carotids; but considering the command which this part of the medullary column exercises over the respiration, and that it is more vital than the brain, may it not be a principal object of the very peculiar course of the vertebral arteries, to supply the organ of respiratory motion free from the casualties which influence the supply of blood to parts of less consequence to life?

It will be objected to these conclusions, that the brain has a certain influence over the action of respiration. I must confess that this subject is obscure or difficult; but even in regard to the voluntary motions of the body, they are not directly from the brain. That relation which makes the four quarters of an animal move in a succession suited for progression; or the combination of the muscles called flexors and extensors, which is necessary to every movement of the limbs, results from an organization in the body: it is not established in the brain, although the brain has a power over it. In the same manner, those relations of the muscles which are necessary to the act of breathing, are established in the medulla oblongata, and nervous cords connected with it, although the brain receives impressions of the condition of the respiratory organs, and the will exercises a certain control over them.

If the nerves of a limb which is separated from the body be excited, the muscles will not all become immediately rigid; there will be *an action* of the limb—the hind leg of the horse will seem to kick. This arises from the association of the muscles in the limb through the nerves, and from their being combined in classes. So in exciting the spinal marrow in the entire animal, there is a certain combination in the movements of the four extremities. Thus the malefactor, after apparent death, under the excitement of the galvanic influence, will spring, gape, and stare. These are so many instances shewing that the system of voluntary nerves in the body is arranged with a view to combinations, and the exercise of the relative classes of muscles produce action in the limbs. The excitement does not produce a tetanic and fixed condition of all the muscles equally; on the contrary, certain relations between them are preserved, and motion of the body and limbs is the effect; and these combinations in action are shewn to exist even if the head be separated from the body. When we look to the action of respiration, and make similar experiments on the respiratory nerves, they will be seen to act according to their peculiar nature or endowment. As the muscles of the limb were combined in the former instance, so the muscles of respiration, however remotely situated, are now combined into one simultaneous action; and whereas in the former, one motion followed each successive application of the stimulus, in the present instance the respiration being once excited continues in a regulated succession of actions, but more and more feebly, until it again stops altogether. Here, then, we perceive, first, that there is a combination between the muscles formed in the body, and independent of the brain; and, secondly, we perceive that there is a peculiarity in the nature of the power exercised upon the muscles, according as they are muscles of volition or muscles of respiration.

The muscles of volition form one system of combined parts, the muscles of respiration form another system altogether; the difference between them is, that in the latter there is a distinct source of influence, which will both preserve the muscles combined together, and cause them to act in a regular succession. There is no more difficulty, I repeat, in conceiving that the mind operates through the nervous system dedicated to respiration, than that it has a power over the infinite variety of combinations of the voluntary muscles; combinations which these experiments shew are established in the frame of the body, and not in the brain.

ON THE ACTIONS OF RESPIRATION IN THOSE WHO HAVE SUFFERED FRACTURE OF THE SPINE AT THE LOWER CERVICAL VERTEBRÆ.

When the spinal marrow is crushed at the upper part of the spine, the man dies instantly; but if the spinal marrow be crushed opposite to the lower part of the neck, although the injury be such as to deprive him of all sense and all voluntary motion of the parts below, he continues to breathe.

It has been stated by our first authorities, that a man in these circumstances breathes by his diaphragm, in consequence of the phrenic nerve, which supplies that muscle, taking its origin from the spinal marrow above the part injured. But the observations have been inaccurately made which have led to this opinion. I shall first shew how untenable such a supposition is, and then detail the phenomena which attend the fracture of the spine at this part; and, finally, shew that other nerves, besides the phrenic, descend from the same source to supply the exterior muscles of the chest, and that it is in a great measure through their influence that the act of respiration is continued.

The diaphragm is that muscular septum which divides the thorax and abdomen, and by the descent of which the depth of the cavities of the chest is increased in inspiration. When it has acted and descended, and the air is admitted into the lungs, that air is again expelled by the reaction of the abdominal muscles. These muscles compress the viscera, and, by pushing them up, raise the relaxed diaphragm, preparing it for another effort of inspiration. Is it not obvious, that, if the power of the diaphragm remain entire, and the power of the abdominal muscles be lost, the respiration must stop? It would be so, were it not that there are other muscles and other nerves no less important than the diaphragm and the phrenic nerves, and which physiologists have not contemplated.

In the first part of this paper, it is shewn that the *sterno-cleido-mastoideus*, the *trapezius*, and the *serratus magnus*, are muscles calculated, by their combined operation, to raise the chest with great force, and to perform inspiration. It is also shewn that the nerves there described as the superior and the external respiratory nerves, take their course exclusively to those muscles which act upon the chest, and that what the phrenic nerves are to the diaphragm, these are to the three great exterior muscles. Were it not for the action of these external muscles which raise and extend the borders of the chest, the diaphragm would exhaust its effort in drawing in the ribs, and expiration would be the consequence of the action of a muscle of inspiration. Further, when it ceased to act, the ribs would exert their elasticity, and dilate the chest during expiration.* It is also shewn in this paper, that as all these nerves take their origins from the same part of the spinal marrow, they are consequently in the same circumstances as to fracture of the spinal tube. When the spine is fractured at the lower cervical vertebræ, these nerves escape injury, and continue to animate the muscles exterior to the ribs, as well as the diaphragm.

The great importance of these exterior nerves and muscles to the continuance of life will be proved by the cases of fracture of the spine. I have purposely omitted all the details of practice, and have taken the symptoms purely in a physiological view, and as if it were an experiment, instead of a most afflicting accident to a fellow creature.

---

* See Appendix.

In these narratives we have the account of the symptoms which accompany fracture of the cervical vertebræ, and which have hitherto been negligently considered. It appeared to me very distinctly, that, in the case first described, the man had the power of drawing his breath by muscular exertion, and that the expulsion of the breath was not a muscular effort, but occasioned entirely by the elasticity of the ribs, and the gravitation of the parts which had been forcibly raised by the action of the muscles. This was evident, in the total want of the power to exert the abdominal muscles, or to compress or depress the chest beyond what was produced by the elasticity of the ribs; in the necessity of raising the chest at the utterance of each word; in the perfect power of yawning, which is a gradual and powerful act of inspiration; in the want of the power of sneezing or blowing the nose, which is a sudden call of the muscles of expiration into action.

The strongest reason of all for maintaining this view of the use of these nerves, which I have called respiratory, is, that respiration and the activity of the muscles of the chest did actually continue after the functions of the spinal marrow were destroyed by violence done to the tube. Now there is no other explanation of this fact, than that those nerves which take their origin from the medulla oblongata and upper part of the spinal marrow, and which descend upon the neck and chest, continued to animate the sterno-cleido mastoideus, the trapezius, the serratus, and the muscles of the throat, in the act of inspiration. We have only further to recollect, that it was not the forcible, occasional, and voluntary motions of respiration that were thus preserved; but by the same means, viz. by the superior and the external respiratory nerves, and the phrenic nerves, the play of the chest in respiration was continued during sleep. If they had been voluntary nerves, their function would have ceased when the patient fell asleep.

In the second case, it is clearly proved, both by the symptoms and the dissection of the bones, that the fracture must have affected the roots of the phrenic nerves; and we are at liberty to conclude, that the difference of symptoms, in comparing it with the first case, as well as the shorter period of his sufferings, was owing to this cause.

The breathing was very different, and is described by our house-surgeon in a manner to produce conviction. *His breathing was like sighing*; and at each inspiration his head was drawn between his shoulders; that is to say, by the loss of the action of the diaphragm, the action was thrown on the muscles exercised through the spinal accessory nerve: and this is confirmed by what is said of the want of motion in the viscera of the abdomen; for, as it was proved in the first case, at each contraction of the diaphragm the viscera of the abdomen were propelled outward.

The want or defect of action in the diaphragm, and the act of breathing being circumscribed to the muscles of the neck and shoulders, were undoubtedly the cause of the patient sinking so soon.

In the cases which follow, it appears that from the spinal marrow being injured so high up as to destroy the roots of all the respiratory nerves, the death was sudden, as in pithing an animal.

I must direct the reader's attention to the very interesting case of disease of the cervical vertebræ, by which these observations are confirmed.

When we have ascertained these facts, certain queries are naturally suggested. Why should these respiratory nerves, which descend from above upon the thorax, go only to muscles which assist in raising and expanding the chest? Why should the act of inspiration be secured by a double provision of nerves, viz. those which come out from the sides of the spine, and those which descend from the neck, when the act of expiration is provided for solely through the former?

I would offer these reasons :—

First, The act of drawing the breath is the more difficult, and requires greater force ; the act of expiration is comparatively easy, being assisted by the weight of the parts incumbent on the ribs, as well as the resiliency or elasticity of the ribs themselves.

Second, The act of inspiration is the active state ; the condition of expiration is a state of rest.

Third, The inspiration is necessary to life, and must be guarded with more care, and performed with more force, than the expiration. In suffocating, the agony is in elevating the chest and drawing the breath. On the approach of death the inspiration becomes more laboured, that is, the exterior muscles are in violent action ; but the act of expiration is an interval of rest.

Fourth, We can blow through a membranous and soft tube, but we cannot inhale by it, for it collapses by the pressure of the atmosphere the moment the attempt is made to draw the air through it. In forcing out the breath, there is no impediment, although the tubes are soft and pliant ; but in drawing in the breath, the sides of the tube fall together, unless they be expanded by consent of many muscles.

Fifth, These nerves, which govern the muscles of inspiration, are linked more intimately by sympathy with the state of circulation and respiration; for we see in disease, as in experiments on animals, that when the powers of life have run low, the sympathy is still exerted with such sudden catching of the muscles of inspiration, and with an effort so powerful and unexpected, as to startle, while the expiration is soft and without effort. We perceive the same sympathy causing the same sudden and powerful inspirations, and marking the presence of life, when a person is recovering from fainting, or from suspended animation, from whatever cause; as drowning, hæmorrhage, &c. The sudden inspiration is always the first of the renewed actions of life, as it is the last in exhausted nature.

This corresponds with the experiments made on animals. When the sensibility is exhausted in the common spinal nerves from the ebbing of life, the respiratory nerves on the neck and side of the chest are still capable of exciting the muscles to renewed vibrations; they are the last to die.

These considerations exhibit the importance of the act of inspiration compared with expiration, and prove the necessity for these exterior nerves of respiration.

We have seen by experiments, that the respiratory nerves are distinguished from the other nerves by retaining their power longer; that they are alive to impression, and can be made to produce convulsions in the muscles they supply, after the other nerves are dead to the application of stimuli. In disease, during the oppression of the mental faculties, and on the approach of death, we witness these nerves, and their muscles put into operation by them, continuing their functions, when in other respects the body is dead. This circumstance, so familiar to the medical observer, might have led to the conclusion to which we have arrived, more laboriously, through anatomical investigations; that there are a great many muscles extended over the body, and which perform the common offices under the will, that are occasionally drawn into combination with the muscles of respiration, and are held in relation to the vital functions by a distinct system of nerves, and that these nerves have a centre and a source of power different from that of the voluntary nerves.*

CONCLUSION.

When we survey the full extent of the respiratory system of nerves, we are prepared to comprehend its importance to the continuance of life. The infant born without a brain can breathe if the origins of these nerves be entire.† Deep wounds of the brain, though eventually fatal, are not necessarily or instantly so. The man wounded in the spine, below the origins of the nerves which we have traced, drags on existence for a few days; but a bruise on the part of the *medulla oblongata*, from which these nerves take their departure, is death in the instant; a breath is not drawn again.

Now, since we find that many respiratory nerves depart from the same centre, and go out to all the parts of the muscular frame which move in respiration, we can better comprehend how injury of the medulla oblongata suppresses at once the act of respiration in the nostrils, throat, and windpipe, as well as the action of the muscles both without and within the chest; even the expression in the agony of dying, is, by the injury of the roots of all these nerves, suddenly interrupted, and actual death follows quickly, owing to the cessation of the respiratory functions.

---

* See Appendix.

† Ibid.

The next thing that strikes us in the vital character of these nerves, called respiratory, is, that as they form a system belonging to the heart, lungs, stomach, larynx, throat, and the whole exterior association of muscles of respiration, and are essential to life, they must be influenced in all mortal affections; and in fact, death cannot take place whilst this division of the nervous system is unchanged or unaffected. But the injury to their roots is attended with immediate death, and the change takes place with appalling suddenness.

On the contrary, if other parts of the body are injured by disease or accident, death comes slowly from the rising of inflammation, or the extension of the influence gradually over the system; at length the respiratory system partakes of the influence, the chest rises higher and more frequently, an alarming symptom, when there is reason to fear approaching dissolution; the throat is then affected; the whole apparatus of respiration is violently agitated; the chest, neck, lips, cheeks, and eye-lids, are wrought with terrible convulsions; the breathing is about to stop; the action returns with sudden and startling effort, and then ceases, the patient dying in the state of expiration, the muscles of inspiration being incapable of renewing the effort.

If it be important to know the approach of danger, and to distinguish nervous agitation from the formidable symptoms of approaching dissolution, it is necessary to know the causes of these symptoms, otherwise the physician is no better than the nurse.

In sleep the offices of the regular nerves are resigned, very uncommon to find the shoulder of a young person falling low, and the appearance of distortion produced by a paralysis of that part of the trapezius muscle which supports the shoulder, and which is supplied by the spinal accessory nerve. This affection forms a parallel with the paralysis of the eye-lid and the cheek; and there are not wanting examples of spasmodic affection of the thorax resembling those which I have just noticed in the side of the face and neck. From inattention to the source and nature of the complaint, the cases in the Appendix are, perhaps, the first which are recorded.

Now we perceive that these nerves of respiration, so peculiar in relation and function, are differently influenced by disease from the other divisions of the nervous system. We know that their functions are left entire when the voluntary nerves have ceased to act, and that they are sometimes strangely disordered, while the mind is entire in all its offices, and the voluntary operations perfect. In tetanus the voluntary nerves are under influence, and the muscles of this class convulsed; in hydrophobia, on the contrary, the respiratory system is affected; and hence the convulsions of the throat, the paroxysms of suffocation, the speechless agony, and the excess of expression in the whole frame, while the voluntary motions are free.

The frequency of sudden death, where no corresponding appearances are exhibited in the brain or heart, leads us to consider more attentively the only part of the system through which life can be directly extinguished. In *angina pectoris*, we witness the agony of suffering in this system when the patient survives; and when he dies suddenly, we can imagine it to proceed from an influence extending over these nerves, and interrupting the vital operations. We have seen that a branch of this system may suddenly cease to operate on the corresponding muscles, and that in this way the side of the face may be deprived of all participation in the act of respiration, and all expression be lost. What would result from a more universal defect in the actions of this class of nerves, but sudden death?

The stomach, supplied with the great central nerve of this system, exhibits the most powerful influence on these extended nerves; a blow on the stomach "doubles up" the bruiser, and occasions that gasping and crowing which sufficiently indicates the course of the injury; a little more severe, and the blow is instantly fatal. A man broken on the wheel suffers dreadful blows, and his bones are broken, but life endures; the *coup de grace* is the blow on the stomach.

The position of the asthmatic shews how this system is affected; whether directly or indirectly, it is not our present business to inquire. He stands stooping forward, resting his arms so as to throw the muscles of the chest into operation upon the ribs. The position of the head and the rigidity of the muscles of the neck, the action of the mastoid muscle, and of the cutaneous muscle, visible in the retraction of the cheeks and mouth, and the inflation of the nostrils, carry us back in review of the nerves and muscles of respiration.

SOME ADDITIONAL NOTES ON THE NERVES OF RESPIRATION.

It will now, perhaps, be acknowledged, that the methods of physiologists, in accounting for the combination of parts in the actions of respiration, were very imperfect, or rather altogether erroneous. To account for the convulsion of the diaphragm in sneezing, they were constrained to go a far way about; first, connecting the roots of the phrenic with the sympathetic nerve; bestowing sensibility on the latter, which it does not possess; then, following a remote connexion between it and the nerves of the nose; then again, counting the relations between the facial nerve and the third of the neck: they satisfied themselves that they had explained the manner in which the diaphragm became convulsed upon irritating the membrane of the nose. Another misconception was ingrafted on the first; they spoke of these actions as convulsive and irregular, which are amongst the most admirable provisions for the protection of life. As to the act of sneezing, like coughing, it is a consequence of an irritation of the fifth pair in the membrane of the nose, whence the whole muscles of respiration are brought into action. That there is nothing accidental, nor of the nature of convulsion, is shewn by the admirable adjustment of the muscles to the object. A body irritating the glottis will call into simultaneous action the muscles of respiration, so as to throw out the air with a force capable of removing the offending body. But if the irritation be on the membrane of the nose, the stream of air is directed differently, and, by the action of sneezing, the irritating particles are removed from these surfaces. By the consideration of how many little muscles require adjustment to produce this change in the direction of the stream of air, we may know, that the action is instinctive, ordered with the utmost accuracy, and very different from convulsion.

OF SMELLING, AS INFLUENCED BY THE PORTIO DURA OF THE SEVENTH NERVE.

In these papers I hope it will be found that I have diligently studied the functions of the parts to which the nerves are sent, before I made my experiments or drew my conclusions. Even in the exercise of the sense of smelling, parts are employed which do not, at first, seem necessary. For the highest enjoyment or exercise of the sense of smelling, the stream of air must be inhaled through the nostrils, changed in its direction, and increased in force. In breathing through the nose, the air is carried directly backward. If the nostrils are expanded in anxious or hurried respiration, the passage is enlarged, and made more direct. But, perhaps, the reader is not aware that in each nostril there are two circular openings, the innermost something more than half an inch within the other. This interior circle expands, and becomes lower when the breath is forcibly drawn into the lungs; but in the act of smelling it is much diminished and elevated. The change in the form and relation of the exterior and internal nostril is produced by the action of the muscles on the cartilages; and the effect of the change is to increase the force of the stream of air, and to direct it up towards the seat of the sense of smelling. In common breathing, some part of the effluvia afloat in the atmosphere reaches the seat of the sense; but fully to exercise the sense it is necessary to concentrate and direct the stream of air, as I have described.

It will now be comprehended how the destruction of the *portio dura*, or respiratory nerve of the face, affects the organ of smelling; for if by the injury of that nerve the motion of the muscles of the nostrils be lost, the breath may be drawn into the lungs through the relaxed passage; but it will not be drawn forcibly up towards the seat of the olfactory nerve, nor will the air brush over the surface on which the proper nerve of sense is expanded.

A man being paralytic on one side of the face by the loss of power in the *portio dura*, he was made to smell ammonia: it did not affect the paralytic side, because it was forcibly inhaled into the cells of the nose only on the side where the nostril was moveable. On trying the experiment on a dog, in which the *portio dura* of one side had been cut, the same thing was manifested; he snuffed it up with the sound side, and shewed the natural consequence of the irritation of the membrane; while he was not similarly affected when the bottle was put to the paralytic nostril. This fact is further illustrated in cases in the Appendix.

Unless I had attended to the structure and function of the part, on witnessing these phenomena, I might have conceived that the seventh nerve was the nerve of smelling, like a noted French physiologist, who concluded too hastily that he had discovered the nerves of vision and of smelling in the fifth nerve.

I allude to certain experiments lately performed in London by a distinguished visiter, which afford a proof of the utter impossibility of reasoning correctly on these subjects without the knowledge of the anatomy. The olfactory nerve was destroyed, and ammonia put to the nostrils of the animal, and when the creature sneezed it was a *coup de theâtre!* Then the gentlemen congratulated themselves that it was discovered that the first pair of nerves was of no use; that the fifth nerve bestowed the sense on the membrane of the nostrils! Yes, surely, the sense of irritation by foreign matter, the property of being stimulated by snuff or dust, or any thing offensive, —but this is not smelling.

The sensibility of the Schneiderian membrane results from the fifth nerve: it was this common sensibility which was here excited by the ammonia. Now, we ask, why does the membrane possess this sensibility, and why is the sensibility joined to the actions of the respiratory system? Because these passages must be guarded as the larynx is guarded. When any thing offensive is lodged there, it must be removed, and the means nature employs is to drive the air by an instinctive action of the respiratory organs, violently and suddenly, through the nostrils. But what has this to do with smelling? As well might we destroy the olfactory nerve, and wonder that the creature experimented on still coughed when the larynx was tickled.

We have some observations on this subject in Mr Shaw's paper already quoted. "The effect upon the nostril is the most obvious symptom, when the nerve is cut in the ass. If after having cut the right nerve *(portio dura)*, we hold the nostril for a short time, so as to prevent the animal from breathing, he will, when freed, begin to snort, but with the left nostril only. If we hold carbonate of ammonia to the paralysed nostril, he will not be affected; but if it be held to the other, he will snuff it up, and then curl the nostril, and have an expression in the whole of that side of the face, as if he were going to sneeze, while the right side will remain quite unmoved."

The rationale of this is worth attention; by the neglect of it some physiologists and experimenters have appeared to much disadvantage. In the animal experimented on, the paralysed nostril was at rest while the other was active and expanded, and the breathing performed through it. Into this side, therefore, the ammonia was powerfully drawn, so as to excite the membrane. This was the reason why, on putting the ammonia to the nostril which was still, the creature was not excited, although there had been nothing done to injure the sensibility of that side of the nose. If a man were simply to draw his breath in taking snuff, the powder would be drawn into his fauces and lungs; but to snuff, the point of the nose is drawn down, and the nostrils contracted, and then, when the air is inhaled, the snuff rises to the superior cells, and stimulates all the interior of the nostrils.* Although by this stimulus he sneezes, the olfactory nerve has nothing to do with it. The luxury is in the stimulus of the respiratory system through the excitement of the membrane, not in the odour as enjoyed by the olfactory nerve. The sensitive branches of the fifth are first excited, then the respiratory system is in a secondary manner affected; and to ascertain whether the mode of communication between the fifth and the respiratory nerves be affected at their roots in the brain, or at their extremities, is a fair question to be determined by experiment or reasoning.

It further appears that we have hitherto been inattentive to the physiology of this familiar act of taking snuff, or the reason of the excitement to the vital powers by ammonia, and to the nostrils in deliquium. We now perceive the advantage to be derived from the excitement of those vital respiratory systems.

THESE RESPIRATORY NERVES ARE ORGANS OF EXPRESSION.

We may notice another office of these respiratory nerves; in smiling, laughing, and weeping, the influence is solely propagated through them. The face, we have seen, is dead to all changes of the kind when the nerve of this class which goes to it is destroyed, whether it be by division of the nerve, or from its being surrounded with inflammation or suppuration. When we consider that all the respiratory nerves depart from the same source, and participate in the same functions, and more especially when we see the respiratory organs so very distinctly affected in the conditions of the mind, which give rise to these affections, it is not too much to suppose, that what is proved in regard to one of these nerves is true of the whole class, and that they alone are influenced in laughter. Physiologists who have not investigated the cause, are yet agreed in describing laughter to be a condition of the respiratory muscles, where the air is drawn in rapidly, and thrown out in short spasmodic motions of these muscles, and crying to be nearly the reverse, the inspiration being cut by spasmodic actions of the muscles of inspiration. By these considerations are explained the ***subrisus*** which proceeds from abdominal irritation, and the sardonic retraction of the muscles of the face produced by wounds of vital parts, and particularly of the diaphragm. They explain also the successive convulsive heaving of the shoulders in wounds of the diaphragm.

---

* See Appendix.

That a system of nerves, so intimately combined as this is with the other parts of the general system, should suffer in hysterical disorders, cannot surprise us; and admitting that the irritation reaches to the respiratory system, we perceive how rapidly the change may be produced, from the convulsions of laughter to those of crying: and that in these affections, if there be a corresponding condition of the mind, it rather follows than precedes the expression of the frame.

It would have been extraordinary if we had arrived at any satisfactory theory of expression, before it was known through what instruments the mind influenced the body during emotion or passion. But since we know that the division of the respiratory nerve of the face deprives an animal of all expression, and that the expressive smile of the human face is lost by an injury of this nerve; since it is equally apparent, that the convulsions of laughter arise from an influence extended over this class of nerves; it comes to be in some sort a duty, in pursuing this matter, to examine farther into the subject of expression. We may be at the same time assured, that whatever serves to explain the constant and natural operations of the frame, will also exhibit the symptoms of disease with more precision.

In terror, we can readily conceive why a man stands with eyes intently fixed on the object of his fears, the eye-brows elevated, and the eye-balls largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we only perceive the intent application of his mind to the objects of his apprehension, and its direct influence on the outward organs. But when we observe him farther, there is a spasm on his breast: he cannot breathe freely: the chest remains elevated, and his respiration is short and rapid: there is a gasping and convulsive motion of his lips: a tremor on his hollow cheeks: a gulping and catching of his throat: his heart knocks at his ribs, while yet there is no force in the circulation, the lips and cheeks being ashy pale.

It is obvious that there is here a reflected influence in operation. The language and sentiments of every people have pointed to the heart as the seat of passion, and every individual must have felt its truth. For though the heart be not in the proper sense the seat of passion, it is influenced by the conditions of the mind, and from thence its influence is extended through the respiratory organs, so as to mount to the throat, lips, and cheeks, and account for every movement in passion, which is not explained by the direct influence of the mind upon the features.

So we shall find, if we attend to the expression of grief, that the same phenomena are presented; and we may catalogue them, as it were, anatomically. Imagine the overwhelming influence of grief—the object in the mind has absorbed the powers of the frame; the body is no more regarded, the spirits have left it; it reclines, and the limbs gravitate, the whole frame is nerveless and relaxed, and the person scarcely breathes: so far there is no difficulty in comprehending the effect in the cause. But why, at intervals, is there a long drawn sigh; why are the neck and throat convulsed, and whence the quivering and swelling of the lip; why the deadly paleness, and the surface earthy cold; or why does convulsion spread over the frame like a paroxysm of suffocation?

To those I address, it is unnecessary to go farther, than to indicate that the nerves treated of in these papers are the instruments of expression, from the smile upon the infant's cheek to the last agony of life. It is when the strong man is subdued by this mysterious influence of soul on body, and when the passions may be truly said to tear the breast, that we have the most afflicting picture of human frailty, and the most unequivocal proof, that it is the order of functions which we have been considering that is then affected. In the first struggles of the infant to draw breath, in the man recovering from a state of suffocation, and in the agony of passion, when the breast labours from the influence at the heart, the same system of parts is affected, the same nerves, the same muscles, and the symptoms or characters have a strict resemblance.

Having examined the system of nerves and muscles, which are the agents in respiration, in their fullest extent, and in all their bearings; having looked at them in their highest state of complication in the human body;

and having traced them upwards, from the animals of simple structure, and then by experiment, and in a manner analytically as well as synthetically, their relations become obvious. Instead of one respiratory nerve, the *par vagum*, the nerve so called is found to be the central one of a system of nerves of great extent. Instead of the relations of the vital organs of circulation and respiration depending on some supposed influence of the sympathetic nerve, they are found to have an appropriate system.

This system of nerves, extricated from the seeming confusion in which it lay hitherto encumbered, is found to be superadded to that of mere feeling and agency, attributes common to all animals. Through it we see, ingrafted as it were, and superadded to the original nature, higher powers of agency, corresponding to our condition of mental superiority : these are not the organs of breathing merely, but of natural and articulate language also, and adapted to the expression of sentiment, in the workings of the countenance and of the breast, that is, by signs, as well as by words. So that the breast becomes the organ of the passions, and bears the same relation to the development of sentiments, that the organs of the senses do to the ideas of sense.

ON THE MOTIONS OF THE EYE,

IN ILLUSTRATION OF

THE USES OF THE MUSCLES AND NERVES OF THE ORBIT.

From the Philosophical Transactions, 1823.

ON THE MOTIONS OF THE EYE, &c.

[*Read before the Royal Society, March* 20. 1823.]

THE object of this paper is to explain the reason of there being six nerves distributed to the eye, and consequently crowded into the narrow space of the orbit.

But, before it is possible to assign the uses of these nerves, we must examine the motions of the eye more minutely than has hitherto been done, and try to comprehend the offices to be performed. Much as the eye has been studied, the frame-work which suspends it, and by which it is moved and protected, has not received the attention it deserves. Yet this frame-work, or apparatus, is not less calculated to renew our wonder, than the properties of the organ itself.

It is, therefore, necessary to divide the paper into two parts. *First*, to shew the uses of the apparatus which is exterior to the eye-ball; and then, in the *second place*, to explain how the nerves minister to these offices.

In this paper I shall consider the former of these subjects: in the next I shall explain the Nerves of the Orbit.

PART I.

OF THE MUSCLES AND FRAME-WORK WHICH ARE AROUND THE EYE-BALL.

EVEN grave and learned men have eulogised this organ as the most necessary to intellectual enjoyment; ranging from the observation of the fixed stars to that of the expression in the human face.* But this admiration is in part misplaced, if given to the optic nerve and ball of the eye exclusively; since these high endowments belong to the exercise of the whole eye, to its exterior apparatus as much as to that nerve which is sensible to the impressions of light. It is to the muscular apparatus, and to the conclusions we are enabled to draw from the consciousness of muscular effort, that we owe that geometrical sense, by which we become acquainted with the form and magnitude, and distance of objects. We might as well expect to understand the uses of a theodolite, or any complicated instrument for observations, by estimating the optical powers of the glasses, without considering the quadrant, level, or plumb-line, as expect to learn the whole powers of the eye by confining our study to the naked ball. I propose to
1 shew, that we must distinguish the motions of the eye,
according to their objects or uses, whether for the direct
purpose of vision, or for the preservation of the organ.
2 I shall shew that the eye undergoes a revolving motion,
3 not hitherto noticed; that it is subject to two distinct
4 states, of rest and of activity; and that the different con-

---

* Sir Henry Wotton, Dr Reid, and many others.

ditions of the retina are accompanied by appropriate con-
ditions of the surrounding muscles; that these muscles 5
are to be distinguished into two natural classes; and that 6
in sleep, faintness, and insensibility, the eye-ball is given
up to the one, while in watchfulness, and the full ex-
ercise of the organ, it is given up to the influence of
the other class of muscles: and, finally, that the consi- 7
deration of these natural conditions of the eye explains
its changes as symptomatic of disease or as expressive of
passion.

MOTIONS OF THE EYE-BALL AND EYE-LIDS.

We shall consider the muscles of the eye, first, as necessary to its preservation; secondly, as belonging to it as the organ of sense. We do not reflect on those actions of our frame which are most admirable in themselves, which minister continually to our necessities, and perfect the exercise of our organs, until we be deprived of them: like unnatural children, unconscious or unmindful of indulgence, we feel only the loss of benefits. "With much compassion," says the religious philosopher, "as well as astonishment at the goodness of our loving Creator, have I considered the sad state of a certain gentleman, who, as to the rest, was in pretty good health, but only wanted the use of these two little muscles that serve to lift up the eye-lids, and so had almost lost the use of his sight, being forced, as long as this defect lasted, to shove up his eye-lids with his own hands?" * I have often thought of this saying when I have seen a patient, in all respects in health, but without the power of raising the eye-lids.

---

* Paley's Natural Theology.

There is a motion of the eye-ball, which, from its rapidity, has escaped observation. At the instant in which the eye-lids are closed, the eye-ball makes a movement which raises the cornea under the upper eye-lid.

If we fix one eye upon an object, and close the other with the finger in such a manner as to feel the convexity of the cornea through the eye-lid, and shut the eye that is open, we shall feel that the cornea of the other eye is instantly elevated; and that it thus rises and falls in sympathy with the eye that is closed and opened. This change of the position of the eye-ball takes place during the most rapid winking motions of the eye-lids. When a dog was deprived of the power of closing the eye-lids of one eye by the division of the nerve of the eye-lids, the eye did not cease to turn up when he was threatened, and when he winked with the eye-lids of the other side.*

Nearly the same thing I observed in a girl whose eye-lids were attached to the surrounding skin, owing to a burn; for the fore part of the eye-ball being completely uncovered, when she would have winked, instead of the eye-lids descending, the eye-balls were turned up, and the cornea was moistened by coming into contact with the mouths of the lacrymal ducts.

---

* The experiment of cutting the facial respiratory nerve was performed on a dog. The following is the note made a few days after the nerve was cut:—The dog is now quite well, having suffered very little from the operation; when he fawns, the right side of his face is completely motionless (the nerve of the right side was cut). When I threatened to strike him, although there is a tremulous motion, expressive of fear, in all the muscles of the left side of the face, the other is perfectly still: he cannot even close the eye-lid; and instead of winking, when he expects to be struck, the eye-ball itself is turned up. When he is excited, there is an expression of alacrity in all the muscles of the left side of the face, and a brilliancy in the left eye, while the right is perfectly inanimate. This is shewn in an extraordinary degree when he is fighting with another dog.

Instead of enforcing this fact, I shall merely refer to the numerous cases in the Appendix in which this motion is proved to take place. I ought not, however, to omit stating, that the fact has been denied, and in very extraordinary terms.

The purpose of this rapid insensible motion of the eye-ball will be understood on observing the form of the eye-lids and the place of the lacrymal gland. The margins of the eye-lids are flat, and, when they meet, they touch only at their outer edges, so that, when closed, there is a gutter left between them and the cornea. If the eye-balls were to remain without motion, the margins of the eye-lids would meet in such a manner on the surface of the cornea, that a certain portion would be left untouched, and the eye would have no power of clearing off what obscured the vision, at that principal part of the lucid cornea which is in the very axis of the eye; and if the tears flowed, they would be left accumulated on the centre of the cornea, and winking, instead of clearing the eye, would suffuse it. To avoid these effects, and to sweep and clear the surface of the cornea, at the same time that the eye-lids are closed, the eye-ball revolves, and the cornea is rapidly elevated under the eye-lid.

Another effect of this motion of the eye-ball is, to procure the discharge from the lacrymal ducts; for by the simultaneous ascent of the cornea and descent of the upper eye-lid, the membrane on which the ducts open is stretched, and the effect is like the elongation of the nipple, to facilitate the discharge of secretion.

By the double motion, the descent of the eye-lid and the ascent of the cornea at the same time, the rapidity with which the eye escapes from injury is increased.

Even creatures which have imperfect eye-lids, as fishes, by possessing this rapid revolving motion of the eye, are enabled to avoid injury and clear off impurities.

I may observe in passing, that, in the manner in which the eye-lids close, there is a provision for the preservation of the eye, which has not been noticed. While the upper eye-lid falls, the lower eye-lid is moved towards the nose. This is a part of that curious provision for collecting offensive particles towards the inner corner of the eye. If the edges of the eye-lids be marked with black spots, it will be seen that when the eye-lids are opened and closed, the spot on the upper eye-lid will descend and rise perpendicularly, while the spot on the lower eye-lid will play horizontally like a shuttle.

To comprehend certain actions of the muscles of the eye, we must remember that the caruncle and membrane called *semi-lunaris*, seated in the inner corner of the eye, are for ridding the eye of extraneous matter, and are, in fact, for the same purpose with that apparatus which is more perfect and appropriate in quadrupeds, called the haw.

The course of our inquiry makes some observation of these parts necessary.

In quadrupeds there is a gland for secreting a glutinous and adhesive fluid, which is seated on that side of the orbit next the nose; it is quite distinct from the lacrymal gland; it is squeezed by an apparatus of muscles, and the fluid exudes upon the surface of the third eye-lid. This third eye-lid is a very peculiar part of the apparatus of preservation. It is a thin cartilage, the posterior part of which is attached to an elastic body. This body is lodged in a division or depression of the orbit on the side towards the nose. When the eye is excited, the eye-ball is made to press on the elastic body, and to force it out of its recess or socket; the consequence of which is, the protrusion of the cartilaginous third eye-lid, or *haw,* as it is termed, in the horse. By this mechanism the third eye-lid is made to sweep rapidly over the surface of the cornea, and by means of the glutinous fluid with which its surface is bedewed, it attaches and clears away offensive particles.

In birds, the eye is an exquisitely fine organ, and still more curiously, and, as we might be tempted to say, artificially protected. The third eye-lid is more perfect; it is membranous and broad, and is drawn over the surface of the eye by means of two muscles which are attached to the back part of the eye-ball, and by a long round tendon, that makes a course of nearly three parts of the circumference of the ball. The lacrymal gland is small, and seated low, but the mucous gland is of great size, and seated in a cavity deep and large, on the inside of the orbit. As the third eye-lid is moved by an apparatus which cannot squeeze the mucous gland at the same time that the eye-lid is moved, as in quadrupeds, the oblique muscles are particularly provided to draw the eye-ball against the gland, and to force out the mucus on the surface of the third eye-lid. It flows very copiously; and this is probably the reason of the smallness of the proper lacrymal gland which lies on the opposite side of the orbit.

We already see that two objects are attained through the motion of the eye-lids and eye-ball; the moistening of the eye with the clear fluid of the lacrymal gland, and the extraction, or rather the protrusion, of offensive particles.

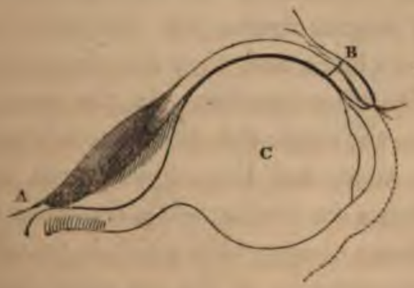
There is another division of this subject no less curious: the different conditions of the eye during the waking and sleeping state remain to be considered. If we approach a person in disturbed sleep when the eye-lids are a little apart, we shall not see the pupil nor the dark part of the eye, as we should were he awake, for the cornea is turned upwards under the upper eye-lid. If a person be fainting, as insensibility comes over him the eyes cease to have speculation ; that is, they want direction, and are vacant, and presently the white part of the eye is disclosed by the revolving of the eye-ball upwards. Look to a blind beggar ; these white balls are not turned up in the fervour of prayer or entreaty ; it is the natural state of the eye-balls, which are totally blind, and from which the attention has been withdrawn. So it is on the approach of death ; for, although the eye-lids be open, the pupils are in part hid, being turned up with a seeming agony, which however is only the mark of increasing insensibility. These motions of the eye, which are for the preservation of the organ, do not interfere with the vision ; they are performed unconsciously. On the other hand, the motions of the eye-ball for directing the eye to objects are strictly voluntary, and are always connected with the exercise of the sense of vision.

It will now be admitted that the variety of motions given to the eye and eye-lids require the complication of muscles which we find in the orbit ; and it must be obvious to the most casual observer, that unless these various offices and different conditions of the eye be considered, it will be in vain to attempt an accurate classification of the muscles of the orbit, and consequently of the nerves.

OF THE ACTIONS OF THE MUSCLES OF THE EYE, AND THEIR NATURAL CLASSIFICATION.

Muscles of the Eye-lid.—Even in the action of these muscles, although the most exposed and familiar of any, there is something still to be observed. The eye-ball is held between the levator palpebræ and the orbicularis, the one tending to the protrusion of the eye-ball, the other to compress and restrain it. In certain cases in the Appendix, we may observe the effect of the paralysis of the orbicularis: that the eye-ball is protruded, and starts farther forward than natural, and that then the eye-lid is loose or flabby, and can be lifted like a bit of common skin.

In other cases in the Appendix, it is shewn that the upper eye-lid is raised, and the lower eye-lid depressed, by one muscle. Anatomists have sought for a depressor of the inferior eye-lid, seeing that it is depressed, but such a muscle has no existence, and is quite unnecessary. The *M. elevator palpebræ superioris* opens wide the eye-lids, depressing the lower eye-lid at the same time that it elevates the upper one. If we put the finger upon the lower eye-lid so as to feel the eye-ball when the eye is shut, and then open the eye, we shall feel that during this action the eye-ball is pushed outwards. Now the lower eye-lid is so adapted as to slip off the convex surface of the ball in this action, and to be depressed whilst the upper eye-lid is elevated.



The origin of the levator being at A, and the insertion into the cartilage of the upper eye-lid at B, the effect of the action of the muscle must be the protrusion of the eye-ball, C, into the dotted line. By the elevation of the upper eye-lid, the eye starts forward a little, and the lower eye-lid slips off the lower segment of the eye-ball. This action of the muscles is happily illustrated by a case in the Appendix. It is curious to observe how the eye-ball retreats in its condition of repose, and is protruded when about to be exercised in vision. The high excitement, as in terror, when the eye-balls are largely unclosed, is attended with an increase of the sphere of vision by the protrusion of the eye-balls, a change remarkable both in the ferocious and timid animals, especially in the latter.

The muscles attached to the eye-ball are in two classes, the recti and obliqui. The recti muscles are four in number, and come from the bottom of the orbit, and run a straight course forwards and outwards; they embrace the eye-ball, and are inserted at four cardinal points into it. The obliqui are two muscles, having a direction backwards and outwards; they embrace the eye-ball, one passing over it obliquely, the other under it obliquely.

That the recti muscles perform the office of directing the axis of the eye, turning it round to every point in the sphere of vision, there are many proofs. In the first place, their origin, course, and insertion, accurately fit them for this office; and they are obviously equal to it, unassisted by other muscles. In the next place, from man down to the cuttle-fish, the voluntary motions of the eyes are the same, and the origin, course, and insertion, of these muscles are similar, while the other muscles vary with the change of apparatus which is round the eye.

The oblique muscles of the eye stand contrasted with the recti in every respect, in number, size, and direction. Yet it is a received opinion, that they antagonize the recti, and keep the eye suspended. To this conclusion there are many objections. 1. In creatures where the eye is socketed on a cup of cartilage and cannot retract, the oblique muscles are, nevertheless, present. 2. Where a powerful retractor muscle is bestowed in addition to the recti muscles to pull the eye-ball back, the oblique muscles have no additional magnitude given to them to pull the eye-ball forwards. 3. In matter of fact, the human eye cannot be retracted by the united action of the recti, as we see quadrupeds draw in their eyes, for the exertion which we give the recti pervades the levator palpebræ also, and its action, as we have just shewn, is to protrude the eye, which is an argument against these muscles being retractors, and therefore against the obliqui being their opponents, to draw it forward.

As we have just observed, the eye-ball is suspended between the muscles within the orbit and the orbicularis palpebrarum anteriorly; this is shewn by the effect of the paralysis of the orbicularis, for then the eye-ball is unnaturally protruded. (See Appendix.)

To these, other objections, no less strong, may be added. We have just found that certain very rapid motions are to be performed by the eye-ball; now it can be demonstrated, that a body will be moved in less time by a muscle which is oblique to the line of motion, than if it lay in the line on which the body moves. If the oblique muscles were either opponents or coadjutors of the recti, there appears no reason why they should be oblique, but the contrary; for as the points of their insertion must move more rapidly than those of the recti, they are unsuitable. On the other hand, that there may be no difference in the time of the action and relaxation of the several classes, we see a reason why one rectus should be opposed by another, and why, there being occasion for one oblique, its antagonist should also be oblique.

In proportion as a muscle gains velocity by its obliquity, it loses power; from the obliquity, therefore, of these muscles believed to be opposed to the recti, and from there being two of them to four of the latter, they are disproportioned in strength, and the disproportion proves that the two classes of muscles are not antagonists.

By dissection and experiment it can be proved, that the oblique muscles are antagonists to each other, and that they roll the eye in opposite directions, the superior oblique directing the pupil downwards and outwards, and the inferior oblique directing it upwards and inwards. But it is proved that any two of the recti muscles are equal to the direction of the pupil in the diagonal between them, and there is no reason why an additional muscle should be given to direct the pupil upwards and inwards, more than upwards and outwards, or downwards and inwards. It is evident, then, that the oblique muscles are not for assisting the recti in directing the eye to objects, else there would have been four of them, but that they must have some other appropriate office. If we proceed farther, it must be by experiment.

EXPERIMENTAL INQUIRY INTO THE ACTION OF THESE MUSCLES.

I. I divided the *superior rectus* or *attollens* in a rabbit, and felt something like disappointment on observing the eye remain stationary. Shortly afterwards, on looking to the animal while it was feeding, I saw the pupil depressed, and that the animal had no power of raising it.

The explanation I conceive to be this: during the experiment the eye was spasmodically fixed by the general action of the muscles, and particularly by the powerful retractor, a muscle peculiar to quadrupeds. But on the spasm relaxing, and when the eye was restored to the influence of the voluntary muscles, the recti, the voluntary power of raising the eye being lost by the division of the superior muscle, the eye was permanently depressed.

II. On opening the eye-lids and irritating the eye of the rabbit, in which the superior rectus muscle had been divided, the eye was turned up; so that, though the voluntary motion was lost by the division of the rectus, the involuntary motion remained by the influence of the obliquus.

III. Wishing to ascertain whether the oblique muscles contract to force the eye-ball laterally towards the nose, I put a fine thread round the tendon of the superior oblique muscle of a rabbit, and appended a glass bead to it, of just sufficient weight to draw out the tendon a little. On touching the eye with a feather, I had the pleasure of seeing the bead drawn up. And, on repeating the experiment, the thread was forcibly drawn through my fingers.

By experiments made carefully in the dead body (having distended the eye-ball by dropping mercury into it, to give it its full globular figure), I had found that the action of the superior oblique muscle is to turn the pupil downwards and outwards, and that the inferior oblique just reverses this motion of the eye. In the above experiment there is abundance of proof that the superior oblique muscle acted, and yet the pupil was not turned downwards and outwards, therefore both oblique muscles must have been in action. Their combined action draws the eye-ball towards the nose.

In the violent spasmodic affection of the eye, when it is painfully irritated, I believe that all the muscles, both of the eye-ball and eye-lids, are excited. In quadrupeds, I have ascertained that the oblique muscles act when the haw is protruded, but I have also found that the retractor oculi alone is capable of forcing forwards the haw.

But quadrupeds having an additional apparatus of muscles to those of the human eye, are not suited for experiments intended to illustrate the motions of our eyes. The monkey has the same muscles of the eye with man.

IV. I cut across the tendon of the superior oblique muscle of the right eye of a monkey. He was very little disturbed by this experiment, and turned round his eyes with his characteristic inquiring looks, as if nothing had happened to affect the eye.

V. I divided the lower oblique muscle of the eye of a monkey. The eye was not, in any sensible manner, affected; the voluntary motions were perfect after the operation.

VI. On holding open the eyes of the monkey, which had the superior oblique muscle of the right eye divided, and waving the hand before him, the right eye turned upwards and inwards, while the other eye had a scarcely perceptible motion in the same direction. When the right eye was thus turned up, he seemed to have a difficulty in bringing it down again.

By these experiments it is proved, first, that the division of the oblique muscles does not in any degree affect the voluntary motions by which the eye is directed to objects. Secondly, that the division of the recti does not prevent the involuntary motions.

In the third place, we have also seen that in winking to avoid injury, the oblique muscles were in operation; and that the inferior oblique muscle gained in the power of elevating the eye-ball by the division of the superior oblique, its opponent.

It would appear that the inferior oblique muscle has a power of elevating the cornea under the eye lid, and causing the eye-ball to revolve many degrees further than the rectus superior does. For if we hold the eye open and excite it, as with a feather, the pupil will turn up quite under the upper eye-lid, and this is an involuntary act; but if we ask the person to turn the eye upwards, as in looking to the ceiling, he cannot direct the pupil beyond the margin of the eye-lid. The fact is obvious enough, and the rationale also; for to what end should there be a power of voluntarily raising the eye-ball in vision, without an accompanying action in the attollens palpebræ, and for what purpose should we have a voluntary power of turning the cornea under the eye-lid? It is obvious that we could not extend the sphere of vision by this action, and as for the object of moistening the cornea, that is more effectually performed by the operation of the inferior obliquus.*

These revolving motions accompanying the winking motions of the eye-lids are of the utmost consequence to the preservation of the organ. A case which was some time under my observation proved this. By a defect of motion, the eye and eye-lids remained fixed, and the consequence was, that the cornea inflamed and became opaque. Another curious circumstance in this case was, that when the eye-lids were closed, the patient still saw red light through the affected eye, the reason of which was that the eye-ball did not turn up when the eye-lid was closed. A case shewing this effect will be found in the Appendix.

If we close the eyes opposite to the window or before a candle, and *continue to attend to the sensations of the eye,* we shall still see red light coming through the eye-lids; and we may observe at this time that the convexity of the cornea has not changed its place; we may feel it in ourselves, or we may observe it in our neighbours. But if we make an effort to close the eye-lids (though they be already shut), we shall be in momentary darkness, because during the effort the eye-balls are then turned up. Thus it appears that the dropping of the eye-lid would make but an imperfect curtain before the eye, and the eye, to be entirely protected from the light, must have the pupil turned upwards.*

---

* See Appendix.

ON THE TWO CONDITIONS OF THE EYE, ITS STATE OF REST AND OF MOTION.

The eye is subject to two conditions,—a state of rest with entire oblivion of sensation, and a state of watchfulness, during which both the optic nerve and the nerve of voluntary motion are in activity. When the eye is at rest, as in sleep, or even when the eye-lids are shut, the sensation on the retina being then neglected, the voluntary muscles resign their office, and the involuntary muscles draw the pupil under the upper eye-lid. This is the condition of the organ during perfect repose.†

On the other hand, there is an inseparable connexion between the exercise of the sense of vision and the exercise of the voluntary muscles of the eye. When an object is seen, we enjoy two senses; there is an impression upon the retina; but we receive also the idea of position or relation, which it is not the office of the retina to give. It is by the consciousness of the degree of effort made by the voluntary muscles that we know the relative position of an object to ourselves. The relation existing between the office of the retina and of the voluntary muscles may be illustrated in this manner :—

---

* In the case above alluded to, the patient had lost both motion and the common sensibility of the eye; the offices of the third and fifth nerve were lost, yet the optic nerve retained its power, and he could see.

† See Appendix, Nos. X, XI, XVI, XVII, XVIII, XXII.

Let the eyes be fixed upon an illuminated object until the retina be fatigued, and in some measure exhausted by the image, then closing the eyes, the figure of the object will continue present to them : and it is quite clear that nothing can change the place of this impression on the retina. But notwithstanding that the impression on the retina cannot be changed, the idea thence arising may ; for by an exertion of the voluntary muscles of the eye-ball, the body seen will appear to change its place, and it will, to our feeling, assume different positions according to the muscle which is exercised. If we raise the pupil, we shall see the body elevated, or if we depress the pupil, we shall see the body placed below us ; and all this takes place while the eye-lids are shut, and when no new impression is conveyed to the retina. The state of the retina is here associated with a consciousness of muscular exertion ; and it shews that vision in its extended sense is a compound operation, the idea of the position of an object having relation to the activity of the muscles.*

We may also shew, by varying this experiment, that an agitated state of the muscles, or a state of action where the muscles are at variance or confused, affects the idea of the image. If we look on the luminous body so as to make this impression on the retina, and then cover the face so as to exclude the light, keeping the eye-lids open, and if we now squint, or distort the eyes, the image which was vividly impressed upon the retina instantly disappears as if it were wiped out. Does not this circumstance take place, because the condition of the muscles thus unnaturally produced, being incongruous with the exercise of the retina, disturbs its operation?

---

* Read on this subject the Essay of Dr Wells on Single Vision.

If we move the eye by the voluntary muscles, while this impression continues on the retina, we shall have the notion of place or relation raised in the mind; but if the motion of the eye-ball be produced by any other cause, by the involuntary muscles, or by pressure from without, we shall have no corresponding change of sensation.

If we make the impression on the retina in the manner described, and shut the eyes, the image will not be elevated, although the pupils be actually raised (as is their condition when the eyes are shut), because there is here no sense of voluntary exertion. If we sit at some distance from a lamp which has a cover of ground glass, and fix the eye on the centre of it, and then shut the eye and contemplate the phantom in the eye; and if, while the image continues to be present of a fine blue colour, we press the eye aside with the finger, we shall not move that phantom or image, although the circle of light produced by the pressure of the finger against the eye-ball moves with the motion of the finger.

May not it be accounted for in this manner?—The motion produced in the eye-ball not being performed by the appropriate organs, the voluntary muscles, it conveys no sensation of change to the sensorium, and is not associated with the impression on the retina, so as to affect the idea excited in the mind. It is owing to the same cause that, while looking on the lamp, by pressing one eye, we can make two images, and we can make the one move over the other. But, if we have received the impression on the retina so as to leave the phantom visible when the eye-lids are shut, we cannot, by pressing one eye, produce any such effect. We cannot, by any degree of pressure, make that image appear to move; but the instant that the eye moves by its voluntary muscles, the image changes its place; that is, we produce the two sensations necessary to raise this idea in the mind; we have the sensation on the retina combined with the consciousness or sensation of muscular activity.

It has been said, that in this experiment the eye-ball does not move, which is the reason that the eye does not seem to move. Then how are we to account for that effect of pressing one eye-ball when the eyes are open? for then we make the images double, and cause the one to move over the other.

It is very remarkable, that the eye will sometimes be observed to move continually, and yet, to the person having that defect, the objects viewed will appear at perfect rest. The cases in the Appendix prove this; there we find that a young woman can thread her needle at the time her eyes are in incessant motion. In this instance, when the eye-lids were held open, and the girl was made to attempt closing them, the eye-ball rolled up and remained stationary. All I can offer in explanation of this is, that she is unconscious of the motion of the eye, and that the idea of motion or change of place is not indicated. The subject is very interesting. — See Appendix.

These experiments and this explanation of the effect of the associated action of the voluntary muscles of the eye-ball, appear to me to remove an obscurity in which this subject has been left by the latest writers. In a most scientific account of the eye and of optics, lately published, it is said on this question, "We know nothing more than that the mind residing, as it were, in every point of the retina, refers the impression made upon it, at each point, to a direction coinciding with the last portion of the ray which conveys the impression." The same author says, Kepler justly ascribed erect vision from an inverted image to an operation of the mind, by which it traces the rays back to the pupil, and thus refers the lower part of the image to the upper side of the eye." What can be here meant by the mind following back the ray through the humours of the eye? It might as well follow the ray out of the eye, and like the spider feel along the line. Another authority says, we puzzle ourselves without necessity. "We call that the lower end of an object which is next the ground." No one can doubt that the obscurity here is because the author has not given himself room to illustrate the subject by his known ingenuity. But it appears to me that the utmost ingenuity will be at a loss to devise an explanation of that power by which the eye becomes acquainted with the position and relation of objects, if the sense of muscular activity be excluded, which accompanies the motion of the eye-ball.

Let us consider how minute and delicate the sense of muscular motion is by which we balance the body, and by which we judge of the position of the limbs, whether during activity or rest. Let us consider how imperfect the sense of touch would be, and how little of what is actually known through the double office of muscles and nerves would be attained by the nerve of touch alone, and we shall be prepared to give more importance to the recti muscles of the eye, in aid of the sense of vision; to the offices performed by the frame-work around the eye-ball, in aid of the instrument itself.

OF THE EXPRESSION OF THE EYE, AND OF THE ACTIONS OF THE OBLIQUE MUSCLES IN DISEASE.

If, as I have alleged, the uses of the oblique muscles of the eye have been misunderstood; and if, as I hope presently to prove, the distinctions of the nerves have been neglected; the symptoms of disease, and the sources of expression in the eye, must remain to be explained.

During sleep, in oppression of the brain, in faintness, in debility after fever, in hydrocephalus, and on the approach of death, the pupils of the eyes are elevated. If we open the eye-lids of a person during sleep or insensibility, the pupils will be found elevated. Whatever be the cause of this, it will be found that it is also the cause of the expression in sickness, and pain, and exhaustion, whether of body or mind: for then the eye-lids are relaxed and fallen, and the pupils elevated so as to be half covered by the upper eye-lid.* This condition of the eye during its insensible unexercised state we are required to explain.

It is a fact familiar to pathologists, that when debility arises from affection of the brain, the influence is greatest on those muscles which are, in their natural condition, most under the command of the will. We may perceive this in the progressive stages of debility in the drunkard, when successively the muscles of the tongue, the eyes, the face, the limbs, become unmanageable; and, under the same circumstances, the muscles which have a double office, as those of the chest, lose their voluntary motions, and retain their involuntary motions, the force of the arms is gone long before the action of breathing is affected.

---

* See a curious case in the Appendix, No. XVII.

If we transfer this principle, and apply it to the muscles of the eye, we shall have an easy solution of the phenomena above enumerated. The recti are voluntary muscles, and they suffer debility before the oblique muscles are touched by the same condition ; and the oblique muscles prevailing, roll the eye.

If it be farther asked, why does the eye roll upwards and inwards? we have to recollect, that this is the natural condition of the eye, its position when the eye-lids are shut and the light excluded, and the recti at rest, and the obliqui balanced.

I have to regret that these minute circumstances regarding the action of the muscles of the eye have led me into so much detail : I hope they are not altogether without interest in themselves, while the discussion will afford me secure ground for establishing an arrangement of the nerves of the eye, and will enable me to distinguish them according to their uses.

SECOND PART OF THE PAPER

ON

THE MOTIONS OF THE EYE.

OF THE NERVES OF THE ORBIT.

From the Philosophical Transactions.

ON THE NERVES OF THE ORBIT.

[*Read before the Royal Society, June* 19. 1823.]

In these Papers I endeavour, to the utmost of my power, to distinguish between the facts which I am able to substantiate, and the hypothesis by which I have been directed in my inquiries. I hope that the importance of the facts may give some bias in favour of that mode of reasoning by which they have been discovered, and an additional interest to anatomical studies.

In my endeavour to arrange the nerves of the orbit, I encounter, in the first step, all the difficulties of my subject; for although there be only nine nerves properly enumerated as proceeding from the brain, six of these go to the eye; the second, third, fourth, part of the fifth, sixth, and seventh, go into the orbit, and may be said to be concentrated into a space no larger than a nut-shell.

In this investigation it is not always possible to give demonstrative evidence, or to answer opposition by cutting across a nerve; here we must proceed on a minute investigation of the anatomy, and by reasoning, rather than by experiment: yet I shall demonstrate what was stated hypothetically, in a former paper, that there is a correspondence between the compound functions of an organ and the nerves transmitted to it.

OF THE FUNCTION OF THE OPHTHALMICUS, A DIVISION OF THE FIFTH NERVE.

We are, in the first place, to inquire by what nerve the common endowment of sensibility is bestowed upon the membranes and surfaces of the eye. On recurring to this subject, we are reminded that the sensibilities of the body differ as much in kind as in degree; that the sensation of pain is provided to rouse our activity, and guard us against violence; or, by means more direct, to excite instinctive motions, which shall anticipate the most rapid actions of the will, and serve as a more perfect safe-guard. The trigeminus, or fifth nerve, bestows upon all the surfaces of the head and face, external and internal, that sensibility which is enjoyed by the rest of the body through the spinal nerves. But through some of its branches is also bestowed that distinct sense on certain parts, for the purpose of drawing the muscles into combination; as, for example, that fine sensibility of the surface of the eye to the presence of minute particles, which at once excites the flow of tears, and draws the muscles into a combination to expel the offensive matter.

It has been shewn in a preceding paper, by experiment, that on dividing the branch of the fifth nerve which goes to the cheek and lips, the skin was deprived of sensibility, although in possession of other nerves, and enjoying muscular activity. The same has been proved in regard to this ophthalmic division; for if that branch of it which comes through the orbit and mounts upon the forehead be divided, the skin will be deprived of sensibility, while the motion of the eye-brow will remain entire.

These facts are so strong, that when supported by the symptoms of disease they afford no apology for deep dissection in the living animal, and authorize the conclusion, that all the branches of the same division of the nerve resemble each other in function, and bestow sensibility on the parts within, as well as on those without.

That the ophthalmic nerve may be deprived of its function, and the parts supplied by it of their sensibility, we may learn from the following instance, communicated to me by Mr Crampton of Dublin. To understand the inference from the short narrative, it is only necessary to remember, that the nerve in question goes through the orbit, supplying the parts contained in it, but that it also extends its branches to the angle of the eye, eye-lids, and fore-head. "A few days after the discharge from the ear had ceased, the eye became entirely insensible to the touch. This loss of feeling extended to the lining of the eye-lids, to the skin covering them, and to the skin of the cheek and forehead, for about an inch surrounding the eye: it did not go beyond the middle line of the face. When she told me her eye was *dead* (as she expressed it), to be certain, I drew my finger over its surface; and so far was this from giving her pain, that she assured me she could not feel that I was touching it at all. The eye-lids made no effort to close while I was doing this, but the conjunctiva appeared sensible to the stimulus, as a number of vessels on the surface of the eye became immediately injected with blood."*

Here we have an insensibility of the eye itself corresponding with the insensibility of the skin, which latter part we know possesses sensibility through the *fifth nerve;* and we therefore conclude, that it is the affection of the same nerve near its root, to which we have to attribute the insensibility of the surfaces of the eye, as well as of the skin around the eye. We must observe in this case, as in others of which I have had experience, that the third nerve remained entire in its functions, and, in some degree, the optic nerve, during the loss of common sensibility.

---

* See the case in the Appendix.

It will be shewn by cases in the Appendix, that the injury of the ophthalmic division of the fifth, at its root, deprives the eye of sensibility. By experiment it can farther be made evident, that the sensibility of the eye, enjoyed through the ophthalmic nerve, does not bestow on the organ directly the power of combining the muscles, either for the defence of the eye, or for any other purpose. The impression must be referred back to the brain, and the muscles be excited by their proper nerves. In experiment I have not been able to excite the motion of the eye by irritating the ophthalmic division of the fifth when its root had been divided;* and in the instance given above, the eye-lids did not move when the surface of the eye was irritated, because no sensation was conveyed inward to the sensorium, and consequently no mandate transmitted from it. The young lady could see, and could move the eye and eye-lids; the eye itself was irritated by touch, as appeared from the rising inflammation; but by the insensibility of the ophthalmic nerve, a link was lost in the relation necessary to join the action of the muscles to the sensibility of the surface.

Cases in the Appendix afford sufficient evidence of the correctness of my conclusion drawn from the consideration of the anatomy; for disease at the part where the ophthalmic nerve is passing forwards entirely took away the sensibility of the surface of the eye and eye-lids, whilst vision and the motion of the eye-lids remained.

---

* In attempting to excite the muscles of the eye by galvanism sent through the fifth nerve, the muscles of the jaw were affected.

By these cases it is farther shewn how curiously the sensibility of the surface of the eye protects it, and that when that sensibility is destroyed, although the motions of the eye-lids remain, these motions are not excited by dust alighting on the eye, nor by injury to the eye; they do not remove the offending body, and consequently inflammation and destruction of the organ follow. These cases also prove that the destruction of the fifth nerve does not cause the loss of the eye by withdrawing vital power from the organ, but simply by destroying the guarding sensibility.

OF THE NERVES PERFORMING THE INVOLUNTARY MOTIONS.

We have just seen that branches of the fifth pair in great profusion come out upon the eye-lids and fore-head, and until these experiments were made, it was supposed that they directed the motions of the forehead and eye-lids. But I have found that they have nothing to do with this function. On the contrary, very small branches of the portio dura, or the respiratory nerve of the face, that nerve which comes out before the ear, control the motions of the forehead and eye-lids. If these small nerves be divided, then the motions of the eye-lids are lost, and they remain open. If, on the contrary, all the nerves, that is to say, the second, third, fourth, fifth, and sixth, should be destroyed, and this small twig remain entire, the *contractions* of the eye-lids remain perfect.* The inquiries instituted in the first part of this paper, give a lively idea of the consequences of the imperfection arising from the defect of these small branches of the portio dura; since they shew that the eye, being unguarded and unwashed, becomes dry by evaporation, inflames, and the cornea becomes opaque. It is unnecessary to point out the importance of this fact to the operating surgeon, which is also proved by the cases in the Appendix.

---

* See Appendix.

I must, however, draw the reader's attention more particularly to the effect of the loss of power in these branches. The tone and action of the orbicularis being lost, the eye is protruded, or rather permitted to come forwards by the absence of opposition. This protrusion of the eye appears so like the effect of disease or of tumor in the orbit, that surgeons have concluded that the cause of paralysis externally was pressure in the orbit; thereby confounding themselves, and countenancing errors in regard to the offices of the nerves.

It has been asked, why should this nerve be called respiratory? and, what have the actions of respiration to do with the eye-lids? The name was given to excite attention to certain relations, and that the connexions of remote parts might be noticed and remembered. These connexions are so curious, the knowledge of them is sometimes so useful, and they are so immediately related to the present subject, that I may be permitted to explain them.

During the state of excitement of the respiratory organs, a very extensive consent of the muscular frame is necessary to bind together and support the textures, that they may bear the strain, either during violent efforts of the body, or in coughing, sneezing, &c. We may take the act of sneezing as a familiar example of the manner in which the eye is guarded during a sudden and violent act of expiration.

At the instant of this convulsive action of the respiratory muscles, a violent impulse is communicated to the head along the column of blood in the vessels of the head and neck. Every body is sensible of the eye flashing light at this moment; but the cause is mistaken, for it is supposed to be the impulse of blood forced into the eye; whereas it is the contraction of the eye-lids to counteract the force of this impulse, and to guard the delicate texture of the eye. If we tap the eye with the finger when the eye-lids are closed, we shall be sensible of the sparks of light. We may produce the same by suddenly and forcibly closing the eye-lids in the dark; but in sneezing, the compression is both more rapid and more forcible, and as the eye-ball receives at once the impulse through the column of the blood from behind, and the resistance of the muscle on the fore part, the sparks are more brilliant. If the eye-lids be held open during the act of sneezing, no sensation of light will be experienced, because the contraction of the eye-lids upon the eye-ball is prevented.

Can we believe this action of the muscle of the eye-lids, in combination with the action of the respiratory muscles, to be through an accidental connexion? Is it not rather a provision to compress and support the vascular system of the eye, and to guard it against the violent rush of blood which attends certain acts of respiration? If we open the eye-lids of a child, to examine the eye while it is crying and struggling with passion, by taking off the natural support from the eye, the blood at the same time being forced violently into the head by the act of respiration, we shall see the conjunctiva suddenly fill with blood, and the eye-lid averted. In short, if any one can have recollection to feel his eye-lids whilst he sneezes, he will require no further words to convince him of the truth of the position; he will feel the eye-lids at that moment as firm as a board.

The respiratory nerve of the face performs two offices, one of which is voluntary, as in moving the cheeks and lips in speech; and the other involuntary, as in moving the nostrils in breathing during sleep or insensibility. In like manner, that branch of the respiratory nerve which is prolonged to the eye-lids performs a double office, contracting the eye-lids by volition, and also producing those involuntary winking motions of the eye-lids which disperse the tears and preserve the lucid surface clear, whilst it causes a correspondence in the motions of the eye-lids with the act of respiration.

But it has been observed, in the first part of this paper, that the shutting of the eye-lids is not the only part of the act of preservation, and that the motions of the eye-lids are attended with a rolling of the eye-ball. How is this relation between the eye-lids and eye-ball established? This leads to an examination of the fourth nerve.

OF THE FOURTH NERVE, AS PERFORMING AN INVOLUNTARY MOTION.

I should, perhaps, not touch upon this subject, because I cannot demonstrate the truth of my opinions as I have hitherto done. However, the question is this, Why should the fourth nerve come from a part of the brain so far back compared with the other nerves? Why should it have a different origin from the nerve which gives sensibility to the surfaces of the eye, as well as from that which gives the voluntary motions to the eye? Why should it take so long a course amongst these common nerves, without exchanging a filament with them?

The fourth is a fine nerve, which takes its origin from the brain, at a part remote from all the other nerves which run into the orbit. It threads the intricacies of the other nerves, without touching the other muscular nerve, and is entirely given to one muscle, the superior oblique.* We may observe, too, that this singularity prevails in all animals. What office can this nerve have in reference to this one muscle? We now reflect, with increased interest, on the offices of the oblique muscles of the eye, observing that they perform an insensible rolling of the eye-ball, and hold it in a state of suspension between them. We have seen that the effect of dividing the superior oblique is to cause the eye to roll more forcibly upwards; and if we suppose that the influence of the fourth nerve is, on certain occasions, to cause a relaxation of the muscle to which it goes, the eye-ball must be then rolled upwards.†

The course of inquiry leads us, in the next place, to observe the vicinity of the root of this fourth nerve to the origin of the respiratory nerve of the face, that is, the nerve of the eye-lids, and we find them arising from nearly the same tract of fibrous substance. The column of medullary matter, which constitutes that part of the medulla oblongata from which the respiratory nerves arise, terminates upwards, or at its anterior extremity, just under the corpora quadrigemina, and there the fourth arises. We have just seen that there is an intimate relation between the orbicularis muscle and the oblique muscle. Is there also a correspondence between the general act of respiration and the rolling of the eye? Led thus to make the experiment, I was gratified to find it so easy to give the proof. On stopping the nostrils with the handkerchief, every effort to blow the nose will be attended by a rapid rising of the cornea under the upper eye-lid. And on every occasion when the eye-lids suffer contraction through the agency of the respiratory nerve of the face, as in sneezing, the eye-ball is rolled upwards. Is this through the agency of the fourth nerve?

---

* It receives a twig from the fifth nerve.

† The nerves have been considered so generally as instruments for stimulating the muscles, without any thought of their acting in the opposite capacity, that some additional illustration may be necessary here. Through the nerves is established the connexion between the muscles; not only that connexion by which the muscles combine in one effort, but also that relation between the classes of muscles by which the one relaxes while the other contracts. I appended a weight to the tendon of an extensor muscle, which gently stretched it and drew out the muscle; and I found that the contraction of the opponent flexor was attended with a descent of the weight, which indicated the relaxation of the extensor. To establish this connexion between two classes of muscles, whether they be grouped together as in the limbs, or scattered widely as the muscles of respiration, there must be particular and appropriate nerves to form this double bond, to cause them to conspire in relaxation as well as to combine in contraction. If such a relationship be established, through the distribution of nerves, between the muscles of the eye-lids and the superior oblique muscle of the eye-ball, the one will relax while the other contracts.

I might, perhaps, be satisfied with having made the observation of these two facts; first, that there is such a combination of the motions of the eye-ball and eye-lids as I have before noticed; and, secondly, that the nerves which move the eye-lids, and the nerve of the obliquus muscle of the eye-ball, are associated at their roots; but I should not do full justice to this interesting subject if I did not attempt something farther. I must confess that in point of anatomy there is still a desideratum. I have not in a manner satisfactory to myself made out the relation between the roots of the portio dura and of the fourth nerve.

It is plain that we must consider the nerves and muscles of the eye-lids in a double capacity; in their voluntary and in their involuntary actions. In the first, the motions of the eye-lids combine with the whole muscles of the eye-ball, as we may perceive in the voluntary contractions and squeezing of the eye. But in the insensible and involuntary motions of the eye-lids there would be no sympathy with the muscles of the eye-ball, and therefore no correspondence in the motion of these parts, without a nerve of the nature of the fourth; that is, a nerve which having diverged from the root of the respiratory nerves, takes its course to the oblique muscle. Does, then, the connexion of its root declare the office of this nerve?

The expression of the eye in passion confirms the truth of this relation being established by a respiratory nerve, and consequently by a nerve of expression. In bodily pain, in agony of mind, and in all this class of emotions, the eyes are raised and dragged, in conjunction with the changes to which the other features are subjected; and so in faintness and in death.* If it be asked now, why the fourth nerve goes into the orbit, where there are so many nerves, why it is so distant in its origin from the other nerves, and why it sends off no twig or branch, but goes entirely to one muscle of the eye? the answer is, that it is a provision for the insensible and instinctive rolling of the eye-ball; and to associate this motion of the eye-ball with the winking motions of the eye-lids;† to establish a relation between the eye and the extended respiratory system: all tending to the security or preservation of the organ itself.‡

---

* See this subject touched upon in the Essay on the Hand.

† Which is necessary in all animals; in fishes, which have no eye-lids, the quick motion of the naked eye-ball removes offensive matter. In the mud-crab, the motion will raise the cornea against the little tuft of hair, which like a brush is ready to wipe the eye!

‡ For the affection of the eye in sleep, and when the patient was dying, see cases in the Appendix.

OF THE VOLUNTARY NERVES.

The voluntary nerves of the eye are the third and sixth. The third nerve arises from the crus cerebri; that track of medullary matter which gives off all the nerves purely of volition. It is given to the muscles of the eye generally, and to no part but muscles. For these reasons we retain the name *motor oculi*, given by Willis, although his reasons for calling it so were fanciful and unsatisfactory. The fifth nerve, by its ophthalmic division, gives branches to the muscle of the eye, but not so profusely as to the surrounding parts; and not more than sufficient to give them sensibility in the degree possessed by muscular substance generally. Since the branches of the fifth nerve, transmitted to the muscles of the eyelids and forehead, do not minister in any degree to muscular action there, it would be unwarrantable to suppose that they served the purpose of giving action to the muscles within the orbit. For these reasons, I conceive the third nerve to be that which gives volition to the muscles of the eye, and that it is, of all the nerves of the body, the most perfectly and directly under the power of the will. In the Appendix we may see, by cases, how inflammation, involving the root of the third pair of nerves, arrested the motions of the eye-ball, and caused it to be turned outwards by the action of the abducens.

The *sixth nerve* is called *abducens*, and *motor externus*. There is no obscurity in this nerve with regard to its origin and distribution; it arises from the same track of medullary matter which gives rise to the motor nerves, and it is distributed to a voluntary muscle, the *rectus externus*. In this respect it is like a subdivision of the third, and without doubt it is a voluntary nerve; but there is a circumstance in its connexion which I cannot explain. It receives a gross branch from the great visceral nerve called Sympathetic. This nerve, ascending through the base of the skull, unites with the sixth nerve as it is entering the orbit. Some, having proceeded so far, would be inclined to call this an accidental connexion, and so leave it ; but similar investigations for many years have brought me to the conviction that there is no accident in an animal body ; and comparative anatomy proves this to be a regular and established relation.

Comparative anatomy may, perhaps, assist us here. In all animals which have the retractor oculi, the sixth nerve is distributed to that muscle, as well as to the rectus externus. This would seem to imply that there is something common to the retractor oculi and the rectus externus. Now as the retractor muscle is always found where there is a haw, as in the horse, and as its action is known to be for the purpose of pushing out the haw, and removing irritation from the surface of the eye, may we not infer that the rectus externus of the human eye is well suited to draw the eye-ball towards the inner canthus, and to produce a similar effect on the caruncle and membrana semilunaris? But in thus accounting for a certain peculiarity in the action of the sixth nerve, we have not a very satisfactory reason why it should be solitary in its origin and course.* I think this abducens muscle of the eye more subject to derangement than the other recti. Whilst this sheet is beside me, I have been consulted by a patient who complains of seeing double when he looks towards the right, although his vision is perfect when his eyes are directed to the left. It is obvious that the abductor of the right eye is incapable of drawing the eye-ball beyond a certain degree: when the left eye moves round beyond this degree, the images of objects begin to separate, and become more and more apart as the left eye traverses to the right. An absolute squint, of a particular kind, in which the pupil is directed to the inner canthus, results from a greater defect of the external rectus. Does the connexion of the sixth nerve with the sympathetic account for such derangements? *

---

* My young men are engaged in prosecuting the branch of the portio dura which penetrates the temporal fascia, and goes through the malar bone into the orbit.

I hope I have now, in a considerable degree, unravelled the intricacy of the nerves of the head, and have assigned to each nerve its proper office. In our books of anatomy the nerves are numbered according to the method of Willis; an arrangement which was made in ignorance of the distinct functions of the nerves, and merely in correspondence with the order of succession in which they appear on raising the brain.

The first nerve is provided with a sensibility to effluvia, and is properly called the olfactory nerve.

The second is the optic nerve, and all impressions upon it excite only sensations of light.

The third nerve goes to the muscles of the eye solely, and is a voluntary nerve by which the eye is directed to objects.

The fourth nerve performs the insensible traversing motions of the eye-ball. It combines the motions of the eye-ball and eye-lids, and connects the eye with the respiratory system.

The fifth is the universal nerve of sensation to the head and face, to the skin, to the surfaces of the eye, the

---

* The case is now very familiar to me. The rectus externus is more subject to derangement than any other muscle of the eye.

cavities of the nose, the mouth and tongue, and the manducatory nerve.

The sixth nerve is a muscular and voluntary nerve of the eye.

The seventh is the auditory nerve, and the division of it, called *portio dura*, is the motor nerve of the face and eye-lids, the respiratory nerve, and that on which the expression of the face depends.

The eighth, and the accessory nerves, are respiratory nerves.

The ninth nerve is the motor of the tongue.

The tenth is the first of the spinal nerves; it has a double root and a double office; it is both a muscular and a sensitive nerve. It assists in supplying the integuments and back of the head, to which the branches of the fifth do not extend.

In concluding these papers, I hope I may be permitted to offer a few words in favour of anatomy, as better adapted for discovery than experiment. The question lies between observation and experiment, and it may be illustrated by astronomy and chemistry. In the first, the objects being beyond our influence, we make observations, not experiments; and the science at length attains a state of perfection which raises our estimate of the human intellect. In the latter, for the most part, the subjects lie out of the sphere of mutual influence; they must be brought together by artifice, and chemistry becomes a science of experiment. But anatomy is more allied to the former than to the latter science, inasmuch as things are obvious to the eyes. In the animal body the parts present distinct textures, and are laid in a natural and perfect order; it is necessary only to trace the tubes, or to observe the symmetrical order of the nervous cords, that we may discover their respective uses; the motions, whether of the solid or fluid parts, are so regular and uniform, that the whole offers a subject for observation and induction. Anatomy is already looked upon with prejudice by the thoughtless and ignorant: let not its professors unnecessarily incur the censures of the humane. Experiments have never been the means of discovery; and a survey of what has been attempted of late years in physiology will prove, that the opening of living animals has done more to perpetuate error than to confirm the just views taken from the study of anatomy and natural motions.

In a foreign review of my former papers, the results have been considered as a further proof in favour of experiments. They are, on the contrary, deductions from anatomy; and I have had recourse to experiments, not to form my own opinions, but to impress them upon others. It must be my apology, that my utmost efforts of persuasion were lost, while I urged my statements on the grounds of anatomy alone. I have made few experiments; they have been simple, and easily performed; and I hope are decisive.

If we turn to the opinions which have been entertained on the subject of the brain and nerves, we find one theory to have prevailed from the Greek authors to the time of Willis, and to have descended from him, with little alteration, to modern writers. The brain has been supposed to secrete and supply a nervous fluid, and the nerves to be the conduit-pipes for its conveyance. In every age the brain has been considered a common sensorium, and all the nerves to be capable of conveying sensation, unless when they had ganglions. If ganglions intervened, then the nerves were said to be cut off from the brain: and those so distinguished were called vital nerves, neither serving the purpose of governing the muscles, nor of conveying sensation. With all this apparent simplicity of doctrine, there never has been presented in the history of any department of science so crude a heap of errors.

These notions were obviously founded on the mistake, that the same nerve serves different purposes, and that a fluid moves in the same tube outwards to stimulate the muscles, and inwards to convey sensation of external impressions. So inconsistent are those opinions with the structure of the frame, that the simplest dissection proves them to be false.

So far is it from being true that ganglions cut off sensation, that I have ascertained, and proved by experiment, that all the nerves, without a single exception, which bestow sensibility, from the top of the head to the toe, have ganglions on their roots; and those which have no ganglions are not nerves of sensation, but are for the purpose of ordering the muscular frame.

The hypothesis, that the nervous fluid streams out from the great *officina* along the nerves has had an unfortunate influence in directing the labours of the experimentalists. During the last age it kept the pupils of Haller engaged in inquiries regarding the influence of the nerves: *de nutritione imprimis nervosa*; and *de nervorum in arterias imperio*: and the interest of the question has not subsided, but, on the contrary, has increased among us.

This notion of a fluid moving backwards and forwards in the tubes of the nerves, equally adapted to produce motion and sensation, has perpetuated the error, that the different nerves of sensation are appropriated to their offices by the texture of their extremities, "that there exists a certain relation between the softness of the nervous extremities, and the nature of the bodies which produce an impression on them." On the contrary, every nerve of sense is limited in its exercise, and can minister to certain perceptions only. Whatever may be the nature of the impulse communicated to a nerve, pressure, vibration, heat, electricity, the perception excited in the mind will have reference to the organ exercised, not to the impression made upon it. Fire will not give the sensation of heat to any nerve but that appropriated to the surface. However delicate the retina, it does not feel like the skin. The point which pricks the skin, being thrust against the retina, will cause a spark of fire or a flash of light. The tongue enjoys two senses, touch, and taste; but by selecting the extremity of a particular nerve, or, what is the same thing, a particular papilla, we can exercise either the one or the other sense separately. If we press a needle against a nerve of touch, we shall feel the sharpness, and know the part of the tongue in contact with the point; but if we touch a nerve of taste, we shall have no perception of form or of place; we shall experience a metallic taste.

I would not say that the innovations of the celebrated Bichat did not bring us a step nearer the truth; since it was a great matter to have ascertained that the ganglions and branches of the sympathetic nerves were positively insensible and incapable of bestowing motion. It is always useful when a man of genius can present familiar subjects in a new view, since it enlivens and excites inquiry. But I think it will not be denied that Bichat paid too little regard to the opinions that prevailed; often assuming that as a novelty which really was not, and doing injustice to those who had preceded him. The best apology for this, perhaps, was the condition of his country at the time he lived. What had been termed the sympathetic system of nerves, he called the ganglionic system; although they are not more distinguishable by ganglions than the other nerves, upon which, indeed, the ganglions are remarkable for their size, number, and regularity. These ganglions must not be thrown out of the system altogether, merely because they are contained within the skull and vertebræ; a circumstance which should rather mark their importance.

The experiments of M. Le Gallois were of the rudest kind possible. The spinal marrow was cut across, or destroyed, by passing skewers into the spinal canal, and the effects were observed; as if the spinal marrow were a simple body. Whereas, by such destruction of its substance, the original ganglions, which form a series along the spine, must have been hurt; the tract of nervous matter which gives rise to the nerves of sensation; that also which gives roots to the nerves of voluntary motion; and the column connected with the offices of respiration, must all have been destroyed by such coarse experiments. It cannot surprise us that the results were obscure and contradictory. But I should regret to be thought insensible to the importance of M. Le Gallois's experiments in regard to the source of the respiratory movements.

The most extravagant departure from all the legitimate modes of reasoning, although still under the colour of anatomical investigation, is the system of Dr Gall. It is sufficient to say, that without comprehending the grand divisions of the nervous system, without a notion of the distinct properties of the individual nerves, or having made any distinction of the columns of the spinal marrow, without even having ascertained the difference of cerebrum and cerebellum, Gall proceeded to describe the brain as composed of many particular and independent organs, and to assign to each the residence of some special faculty.

When the popularity of these doctrines is considered, it may easily be conceived how difficult it has been, during their successive importations, to keep my pupils to the examples of our own great countrymen. Surely it is time that the schools of this kingdom should be distinguished from those of other countries. Let us continue to build that structure which has been commenced in the labours of the Monros and Hunters,* and which the undeserved popularity of the continental system has interrupted.

---

* While printing the last sheets of these papers, I took up Mr Hunter's work on the Animal Economy, to consult him on the distribution of the nerves to the nose. I was as much surprised with the following passage as if I had never before read it. This work of Mr Hunter's was my earliest acquisition as a medical student, and often perused with deep interest; I believe I might trace back the course of my reflections to it, although during the prosecution of this subject it never occurred to me that I was indebted to him. I have often hung over the plates of Monro, certain that there was an arrangement to be discovered which would explain the seeming confusion of the nervous system, but I was not so sensible of what I owed to Mr Hunter. I am happy that I fell so opportunely on this passage, and inexpressibly gratified to find a support of some of my opinions in such authority :—

"The nerves being in themselves, perhaps, the most difficult parts of an animal body to dissect, becomes a reason why we are still unacquainted with many of their minuter ramifications: yet, if a knowledge of these, together with that of their origin, union, and re-union, is at all connected with their physiology, the more accurately they are investigated, the more perfectly will the functions of the nerves be understood. I have no doubt, if their physiology was sufficiently known, but we should find the distribution and complication of nerves so immediately connected with their particular uses, as readily to explain many of those peculiarities for which it is now so difficult to account. What naturally leads to this opinion is, the origins and number of nerves being constantly the same; and particular nerves being invariably destined for particular parts. The fourth and sixth pair of nerves are remarkable instances of this; and we may reasonably conclude, that every part has its particular branch allotted to it; and that however complicated the distribution may be, the complication is always regular. There are some nerves which have a peculiarity in their course, as the recurrent and chorda tympani; and others which are appropriated to particular sensations, as those which go

The whole history of medical literature proves, that no solid or permanent advantage is to be gained, either to medical or general science, by physiological experiments unconnected with anatomy. To disregard the anatomy

---

to four of the organs of sense, seeing, hearing, smelling, and tasting; and some parts of the body having peculiar sensations (as the stomach and penis), we may, without impropriety, include the fifth, or sense of feeling. This general uniformity, in course, connexion, and distribution, will lead us to suppose that there may be some other purpose to be answered more than mere mechanical convenience; for many variations have been described in the dissections of nerves, which I believe to have arisen from the blunders of the anatomist, rather than from any irregularity in their number, mode of ramifying, course, distribution, or connexion[*] with each other. We observe no such uniformity in vessels carrying fluids; but find particular purposes answered by varying their origin and distribution: the pulmonary artery answers a very different purpose, in the circulation of the blood, from that of the aorta; yet both arise from the same source, the heart. The course of the arteries is such as will convey the blood most conveniently, and, therefore, not so necessary it should be uniform; it not being very material to a part by what channel the blood is conveyed; though, in particular instances, certain purposes may be answered by a peculiarity in origin and distribution, as happens in the testicle of quadrupeds. This observation respecting arteries is likewise applicable to veins, and still more to the absorbent vessels, in which last, regularity is even less essential than in the veins. Whoever, therefore, discovers a new artery, vein, or lymphatic, adds little to the stock of physiological knowledge; but he who discovers a new nerve, or furnishes a more accurate description of the distribution of those already known, affords us information in those points which are most likely to lead to an accurate knowledge of the nervous system: for if we consider how various are the origins of the nerves, although all arising from the brain, and how different the circumstances attending them, we must suppose a variety of uses to arise out of this peculiar structure. Indeed, if we reflect on the actions arising immediately from the will, and affections of the mind, we must see that the origin, connexion, and distribution of the nerves must be exact, as there are parts whose actions immediately depend upon such circumstances."

[*] "Here it is to be understood I do not mean lateral connexion; such as two branches uniting into one cord and then dividing; or a branch going to a part, either single or double, for still it is the same nerve; or whether a branch unites with another a little sooner or a little later, for still it is the same branch. Such effects may arise more from a variety in the shape of the bodies they belong to, than any variety in the nerves themselves."

of the nervous system, or to take it in the gross, and, influenced by a false analogy, to call life a fluid, and to attempt to direct it along a cord or a wire, is to transgress all the rules of philosophical inquiry. Were such a method continued, it would be attended with the rapid decline of anatomical studies. They would be considered as imposing restraints on genius, or be rejected as useless; and with them pathology, and the other studies which are the foundations of medical science, would fall into disuse.

ON THE NERVOUS CIRCLE

WHICH CONNECTS THE

VOLUNTARY MUSCLES WITH THE BRAIN.

From the Philosophical Transactions.

ON THE NERVOUS CIRCLE, &c.

[*Read before the Royal Society, February* 16. 1826.]

IN the papers which I have had the honour of addressing to the Society on the arrangement of the nerves of the human body, I have proceeded upon a comparison of the nerves of the spinal marrow with the nerves of the encephalon.

It was shewn that the former were compounded of filaments possessing different powers, and that each nerve, having several properties or endowments collected within itself, proceeded to its destination without intricacy.

Unless we had discovered the composition of the roots of these nerves, we should have continued to suppose that one nerve was simple in its structure, and yet capable of bestowing the very different properties of motion and sensation.

But having satisfied myself that the roots of the spinal nerves had distinct powers, I followed up the columns of the spinal marrow; and with a knowledge of the composition of those nerves as a key, I examined the different properties of the nerves of the encephalon. Here, in the head, the nerves arise simply, and diverge to their destinations without the close compact or union which the spinal nerves form; and accordingly, the anatomy of these nerves of the brain affords satisfactory proof of their uses or functions. I am about to shew that every muscle has two nerves, of different properties, supplied to it.

This I could not have ascertained by examination of the spinal nerves alone, because of the intimate union of all their fibres; I had recourse therefore to the nerves of the head. By prosecuting those inquiries, which led to the distinction of the different classes of nerves, I hope now to demonstrate—*that where nerves of different functions take their origin apart and run a different course, two nerves must unite in the muscles, in order to perfect the relations between the brain and these muscles.*

It may be in the recollection of the Society, that my first paper shewed a difference in the nerves of the face; that by dividing one nerve, sensation was destroyed, whilst motion remained; and by dividing the other, motion was stopped, whilst sensibility remained entire.

Other parts of the nervous system since that time have engaged my attention; and it is only now that I am able to make full use of the facts announced in my first paper, which were indeed expected to lead to further improvement of our knowledge of the animal economy. When I distinguished the two classes of nerves going to the muscles of the face, and, on dividing the motor nerve, shewed that the muscles were deprived of motion by this experiment, the natural question suggested itself—Of what use are the nerves that remain entire?

For a time I believed that the fifth nerve, which is the sensitive nerve of the head and face, did not terminate in the substance of the muscles, but only passed through them to the skin; and I was the more inclined to this belief on observing that the muscular parts, when exposed in surgical operations, did not possess that exquisite sensibility which the profusion of the sensitive nerves would imply, or which the skin really possesses.

Still, dissection did not authorize that conclusion. I traced the sensitive nerves into the substance of the muscles: I found that the fifth pair was distributed more profusely to the muscles than to the skin; and that, estimating all the nerves given to the muscles, the greater proportion belonged to the fifth or sensitive nerve, and the smaller proportion to the seventh or motor nerve. On referring to the best authorities, as Meckel,* and my excellent preceptor Monro, the extremities of the fifth were described by them as going into the muscles; so that of this fact there cannot be a doubt.

Having in a former paper demonstrated that the portio dura of the seventh nerve was the motor of the face, and that it ran distinct from the sensitive nerve, the fifth; and having observed that they joined at their extremities, or plunged together into the muscles, I was nevertheless unwilling to draw a conclusion from a single instance; and therefore cast about for other examples of the distribution of the muscular nerves. It was easy to find motor nerves in combination with sensitive nerves, for all the spinal nerves are thus composed; but we wanted a muscular nerve clear in its course, to see what alliance it would form in its ultimate distribution in the muscle. I found in the lower maxillary nerve the example I required.

The fifth pair, from which this lower maxillary nerve comes, as I have elsewhere explained, is a compound nerve; that is to say, it is composed of a nerve of sensation and a nerve of motion. It arises in two roots; one of these is the muscular nerve, the other the sensitive nerve: on this last division the Gasserian ganglion is formed. But we can trace the motor nerve clear of the ganglion and onward in its course to the muscles of the jaws, and so it enters the temporal, masseter, pterygoid, and buccinator muscles.

---

* Meckel De quinto Pari Nervorum Cerebri.

If all that is necessary to the action of a muscle be a nerve to excite contraction, these branches should have been unaccompanied; but, on the contrary, I found that before these motor nerves entered the several muscles, they were joined by branches of the nerves which came through the Gasserian ganglion, and which were sensitive nerves.

I found the same result on tracing motor nerves into the orbit, and that the sensitive division of the fifth pair of nerves was transmitted to the muscles of the eye, although these muscles were supplied by the third, fourth, and sixth nerves.

A circumstance observed on minute dissection remained unexplained,—when motor nerves are proceeding to several muscles they form a plexus; that is, an interlacement and exchange of fibres takes place.

The muscles have no connexion with each other, they are combined by the nerves; but these nerves, instead of passing betwixt the muscles, interchange their fibres before their distribution to them, and by this means may combine the muscles into classes. The question therefore may thus be stated: Why are nerves, whose office it is to convey sensation, profusely given to muscles in addition to those motor nerves which are given to excite their motions? and why do both classes of muscular nerves form plexuses?

To solve this question, we must determine whether muscles have any other purpose to serve than merely to contract under the impulse of the motor nerves. For if they have a reflective influence, and if their condition is to be felt or perceived, it will presently appear that the motor nerves are not suitable internuncii between them and the sensorium.

I shall first inquire whether it be necessary to the *governance of the muscular frame that there shall be a consciousness of the state or degree of action of the muscles?* That we have a sense of the condition of the muscles, appears from this: that we feel the effects of over exertion and weariness, and are excruciated by spasms, and feel the irksomeness of continued position. We possess a power of weighing with the hand:—what is this but estimating the muscular force? We are sensible of the most minute changes of muscular exertion, by which we know the position of the body and limbs, when there is no other means of knowledge open to us. If a rope-dancer measure his steps by the eye, yet, on the other hand, a blind man can balance his body. In standing, walking, and running, every effort of the voluntary power which gives motion to the body is directed by a sense of the condition of the muscles; and without this sense we could not regulate their actions.

If it were necessary to enlarge on this subject, it would be easy to prove that the muscular exertions of the hand, the eye, the ear, and the tongue, are felt and estimated when we have perception through these organs of sense; and that without a sense of the actions of the muscular frame, a very principal inlet to knowledge would be cut off.

If it be granted that there must be a sense of the condition of the muscle, we have next to shew that a motor nerve is not a conductor towards the brain, and that it cannot perform the office of a sensitive nerve.

Without attempting to determine the cause, whether depending on the structure of the nervous cord, or the nature or the source of the fluid contained, a pure or simple nerve has the influence propagated along it in one direction only, and not backwards and forwards; it has no reflected operation or power retrograde; it does not both act from and to the sensorium.

Indeed, reason without experience would lead us to conclude, that whatever may be the state, or the nature of the activity of a motor nerve during exertion, it supposes an energy proceeding *from* the brain *towards* the muscles, and precludes the activity of the same nerve in the opposite direction at the same moment. It does not seem possible, therefore, that a motor nerve can be the means of communicating the condition of the muscles to the brain.

Expose the two nerves of a muscle; irritate one of them, and the muscle will act; irritate the other, and the muscle will remain at rest. Cut across the nerve which had the power of exciting the muscle, and stimulate the one which is undivided, the animal will give indication of pain; but although the nerve be injured so as to cause universal agitation, the muscle with which it is directly connected does not move. Both nerves being cut across, we shall still find that by exciting one of the nerves attached to the muscle, the muscle is made to act, even days after the nerve has been divided; but the other nerve, though equally attached and distributed to the muscle, has no influence at all.

Anatomy forbids us to hope that the experiment will be as decisive when we apply the irritants to the extremities of the divided nerves which are connected with the brain; for all the muscular nerves receive more or less minute filaments of sensitive nerves, and these we can trace into them by the knife, and consequently they will indicate a certain degree of sensibility when hurt. To expose these nerves near their origins, and before any filament of a sensitive nerve mingles with them, requires the operator to cut deep, to break up the bones, and to divide the bloodvessels. All such experiments are much better omitted; they never can lead to satisfactory conclusions.

Experience on the human subject most abundantly illustrates these facts. For example:—a patient of mine having, by a tumour pressing on the nerves of the orbit, lost the sensibility of the eye and eye-lids, she retained the motion of the eye-lids by the portio dura coming round externally and escaping from the pressure which injured the other nerves. Here the course of sensibility backwards to the brain was cut off, while the course of volition forwards was free. She could not tell whether the eye-lid was open or shut, but being asked to shut the eye which was already closed, she acted with the orbicular muscle and puckered the eye-lids. Nay, when the eye was scarified she had no sensation, and did not wink with the eye-lids. There was no motion in this case, because the sensitive fifth pair had lost its power to carry back sensation, although she could command the motion by voluntary exertion. It will further be remarked in the cases in the Appendix, that if the patient could see, he shrunk and winked when a blow was aimed at the eye, although there was no motion when the eye was touched with a feather. Here the sensation was conveyed backwards by the optic nerve when the patient winked; for the fifth had lost its power.*

In another instance, when the eye was insensible, touching the eye gave rise to a blush of redness and to inflammation, because the *part* was excited; nevertheless the muscles were not called into action. The relations which connect the sensibility of the eye with the motions of the eye and eye-lid, are established in the roots of the fifth and seventh in the brain; the loss of function of the fifth nerve therefore interrupted the circle. Here too the motor nerve of the eye-lid was perfect, and the eye-lid readily acted under the influence of the will; but when the eye-lid was touched or pricked it communicated no sensation. Is this insensibility of a motor nerve owing to the course of its influence being from the brain, and not towards it? When the nostril had lost its sensibility from an affection of the fifth pair, we could not excite sneezing;* when the tongue and cheek had lost sensibility, the morsel was permitted to remain between the tongue and the cheek until it was offensive, although the motions both of the tongue and the cheek were perfect.† All these phenomena correspond with the experiments on animals.‡

---

* A patient lately in the physicians' wards, had amaurosis in one of his eyes, and loss of sensation in the other. When the finger was presented towards the eye, in which he could see but with which he could not feel, he drew back and winked; yet when the finger touched the surface, he did not even close his eye. When the finger touched the blind eye, or the eye-lashes, he instantly closed the eye-lids spasmodically.

Now, it appears that the muscle has a nerve in addition to the motor nerve, which being necessary to its perfect function, equally deserves the name of muscular. This nerve, however, has no direct power over the muscle, but circuitously through the brain, and by exciting sensation it becomes a cause of action.

Between the brain and the muscles there is a circle of nerves; one nerve conveys the influence from the brain to the muscle, another gives the sense of the condition of the muscle to the brain. If the circle be broken by the division of the motor nerve, motion ceases; if it be broken by the division of the other nerve, there is no longer a sense of the condition of the muscle, and therefore no regulation of its activity.*

---

* See Appendix.

† Ibid.

‡ See further in the Appendix. See also the case communicated by Dr Ley, and that which follows it.

We have noticed, that there is a plexus formed both on the nerves which convey the will to the muscles, and on the nerves which give the sense of the condition of the muscles. The reason of this I apprehend to be, that the nerves must correspond with the muscles, and consequently with one another. If the motor nerve has to arrange the action of several muscles so as to produce a variety of motions, the combinations must be formed by the interchange of filaments among the nerves before they enter the muscles, as there is no connexion between the muscles themselves. As the various combinations of the muscles have a relation with the motor nerves, the same relations must be established by those nerves which convey the impression of their combinations, and a similar plexus or interchange of filaments therefore characterizes both.†

We have seen that the returning muscular nerves are associated with the nerves of sensibility to the skin, but they are probably very distinct in their endowments, since there is a great difference between conveying the sense of external impressions, and that of muscular action.

---

* Thus led to conclude that there is motion in a circle, we nevertheless cannot adopt the hypothesis of circulating fluids. That a fluid does not proceed from the brain, we may learn from this; that on touching the end of a motor nerve which has been some days separated from the brain, the muscle is excited as when the nerve was first divided. The property, however it may be defined, is therefore in the nerve. Our language might perhaps be made more precise if we used terms which implied the course of nervous influence, whether from or towards the brain; but it will be difficult to express this without the aid of hypothesis.

† The pupils must be put on the pursuit of some of the points of the anatomy connected with this subject.

In surgical operations the fact is forced upon our attention, that the pain of cutting the skin is exquisite, compared with that of cutting the muscles; but we must remember that pain is a modification of the endowment of a nerve, serving as a guard to the surface, and to the deeper parts consequently. This is further exemplified in the sensibility of the skin to heat; whilst, on the contrary, a muscle touched with a hot or cold sponge during an operation, gives no token of the change of temperature but by the degree of pain.

Many of the nerves which perform the most delicate operations of the economy, are not more sensible to pain than the common texture of the frame. The lower degree of sensibility to pain possessed by the muscles, and their insensibility to heat, is no argument against their having nerves which are alive to the most minute changes of action in their fibres.*

When the anatomist shall find both the portio dura of the seventh and the fifth going to the integuments of the head and face, he may naturally ask, Why are there two nerves to the surface? and he will probably reflect, that although the principal office of the nerves of the skin is to convey impression to the sensorium, yet the influence of the mind is conveyed to the surface. The condition of the mind in passion, for example, is as forcibly communicated to the skin as to the muscles themselves; and therefore if a branch of the fifth be necessary to convey sensation from the surface to the sensorium, the seventh is necessary to the change of vascular action, and to the condition of the pores when affected by a cause proceeding from within, outwards.

---

* The reader will find this subject pursued in the Author's Bridgewater Treatise on the HAND.

I feel a hesitation when I reason upon any other ground than on the facts of anatomy. Experiments are more apt to be misinterpreted; and the very circumstance of a motor and sensitive nerve being generally combined together, affords a pregnant source of error.

It is natural to suppose that the galvanic influence might be brought to bear on this subject; but I may be permitted to suggest to any one who pursues it in this way, that it will be necessary to distinguish the effects produced by the nerve as a mere conductor, and when performing its living functions. The nerve, dead or alive, may convey the galvanic power like a wet cord; but if the nerve be in possession of its living property, a great deal will depend on the direction in which the galvanic fluid is transmitted. If it be transmitted against the course of the nervous influence, it will reach the muscles and act feebly, although the power of the nerve be not in this case exercised upon the muscle; but if it be transmitted in the proper course towards the muscles, the nerve itself will be excited, and its power propagated so as to produce violent action in the corresponding muscles.*

---

* Professor Müller of Berlin's experiments confirm these remarks. After cutting across the roots of the spinal nerves (in a frog) he embraced the posterior roots between the two galvanic poles, when the muscles remained quiescent. But on applying one pole upon the cut extremity of the posterior root of the nerve, and the other upon the muscles, they immediately contracted. He next took the extremities of the anterior root and repeated the experiment as above: in *both* experiments the muscles contracted; and when these anterior roots were placed between the poles the contractions were most powerful.

The next experiment is happily contrived. He bruised the nerve in its course; after which, on applying the galvanic influence to the anterior root, the muscle did not act; but on extending the poles, *i. e.* one pole being on the anterior root and the other on the muscle, the muscle contracted. In this last experiment the nerve was acting as a conductor merely, not by its living property.

ON THE FUNCTIONS OF SOME PARTS OF THE BRAIN,

AND

ON THE RELATIONS BETWEEN THE BRAIN AND NERVES OF MOTION AND SENSATION.

From the Philosophical Transactions.

ON THE FUNCTIONS OF SOME PARTS OF THE BRAIN, &c.

[*Received by the Royal Society March* 3.—*Read May* 15. 1834.]

THE difficulties which attend the investigation of the structure and functions of the brain are shewn by the ineffective labours of two thousand years; and the first endeavour of the author is to remove the idea of presumption that attaches to the very title of this paper. Perhaps the enumeration of some of the sources of error which have retarded discovery may be the best introduction and apology.

The first impediment to success is in the nature of the inquiry, since extraordinary and contradictory results must be expected from experimenting on an organ so fine as that must be which ministers to sensibility and motion, and which is subject to change on every impression conveyed through the senses. This remarkable susceptibility is exemplified in what we often witness; extraordinary results, such as violent convulsions and excruciating pain, from causes which appear quite inadequate. For example, the presence of a minute spicula of bone which has penetrated to the brain, will at one time be attended with no consequence at all; at another, it will occasion a deep coma, or loss both of sensibility and motion. Nay, symptoms, apparently as formidable, will be produced by slight irritation on remote nerves. Seeing these contradictory effects, is it reasonable to expect constant and satisfactory results from experiments in which deep wounds are inflicted on the brain of animals, or portions of it torn away?

Other circumstances evince the slight varieties in the causes which produce the most extraordinary effects. Water in the brain, which has free access to all the cavities of the brain, and which to all appearance both presses equally and, if it irritate, must irritate equally, will have the effect of rendering one side of the body paralytic, and of convulsing the other with incessant motion.

Another source of error, especially to the experimenter on the brain, is the disturbance of its circulation; for the brain depends more directly than any other organ on the condition of the circulation within it. We may see this in the provisions for the free and equable supply of the blood within the head, as well as for its unimpeded exit. Now, by raising the skull, a necessary preliminary to most experiments on the substance of the brain, there is an immediate disturbance of the circulation, which of itself may be attended with insensibility or convulsions.

The most frequent source of error, perhaps, is the obscurity which hangs over the whole subject; for although the brain be divided naturally into distinct masses, not one of these grand divisions has yet been distinguished by its function. There is not even an opinion as to their relative importance. Hence it has followed that the experimenter has not known what to seek, or how to plan his experiment; and hence have been derived the weakest fancies that have ever obscured any science. Another difficulty meets the inquirer at every step if he be not critically guarded. Whole masses of the brain may be destroyed by disease, or actually removed with impunity; that is to say, without any immediate influence on the mind, or on the power of motion or of sensibility; yet the very slightest general impression on the brain will in the instant deprive the individual both of sense and motion.

It will not be denied that the most unequivocal proof of the little success which has attended the efforts made to improve this part of physiology, is the failure of all attempts to explain the phenomena which attend injury of the brain; it is neither said why, in disease of the brain, sensation and motion should be lost together, nor why one faculty should sometimes be imperfect and the other entire. There is no satisfactory reason given for the most common occurrence in practice, the loss of motion and sensation on the side of the body opposite to that side of the brain which has received the injury; nor has the condition of the face, as associated with that of the body, been accounted for. When circumstances so remarkable present themselves daily, consequent upon accident or disease affecting the brain, without our teachers succeeding in offering a satisfactory reason for them, it is obvious that we are in a state of profound ignorance of the most interesting functions of the animal body, notwithstanding the innumerable experiments which have been made upon the brains of animals.

These are probably the reasons why ingenious men have failed to make us acquainted with the distinct functions of the divisions of the brain, and countenance us in advancing to the inquiry in a manner altogether different. If the real intricacy of the brain, and the disappointments met with, have inclined many to consider it as an inextricable labyrinth, we may well doubt whether the thread which is to lead us through has been properly selected. This term is not altogether metaphorical, since it is our design to follow the course of the natural filaments discernible in the nervous matter of the brain. The investigation into the substance of the brain must be made in a manner different from common dissection; there is a new element to conquer. Every part of the brain is closely united and pent up within the skull, for the protection of its delicate substance. This compactness of structure guards the brain against impulse from within as well as from external injury; but whether the whole of this structure be essential and of primary importance, or whether some part may not perform the merely accessory office of packing and joining together the more delicate parts, and so securing the finer filaments which run through it, is, even up to the present time, matter of conjecture. However, it is to the filamentous and striated texture that we attach importance, as leading to the right path, and as marking the relations which exist between the parts of the brain, and the connexions of these with the nerves distributed over the body. The advantage with which we now enter on this inquiry is obvious, for instead of seeking, by injuring the substance of the brain, to discover the effects on remote parts of the nervous system, we commence the inquiry with a knowledge of that system.

It being now universally allowed that nerves have distinct functions, and not a common quality, and that the sensitive and motor roots of the nerves spring from different sources, it must appear a very natural mode of inquiry to follow these nerves into the brain, and to observe the tracts of nervous matter from which they take their origin. It is surely an easy, as well as a natural, proceeding, to follow these tracts, and to mark the portions of the brain to which they ultimately tend; finally, to inquire what is the effect of the diseases of these parts, what the accompanying symptoms, and to compare the symptoms with the anatomical details.

On this plan I now propose to demonstrate that sensibility and motion belong to the cerebrum,—that two columns descend from each hemisphere,—that one of these, the anterior, gives origin to the anterior roots of the spinal nerves, and is dedicated to voluntary motion,—and that the other (which from its internal position is less known) gives origin to the posterior roots of the spinal nerves, and to the sensitive root of the fifth nerve, and is the column for sensation.

Further, I propose to shew that the columns of motion which come from different sides of the cerebrum join and decussate in the medulla oblongata,—that the columns of sensation also join and decussate in the medulla oblongata. Finally, that these anterior and posterior columns bear, in every particular, a very close resemblance to one another,—that is to say, the sensorial expansions of both are widely extended in the hemispheres: they pass through similar bodies towards the base of the brain, and both concentrate and decussate in the same manner, thus agreeing in every respect, except in the nervous filaments, to which they give origin.

OF THE STRIATED SEPTA IN THE MEDULLA OBLONGATA AND PONS VAROLII.

We can have no hesitation in giving superior importance to those tracts of striated matter which descend from the brain to the spinal marrow, since they are obviously the lines of communication between the organ of the mind and the frame of the body. But these longitudinal tracts are separated by certain plates of fibrous matter, which go directly transverse, are very regular, very easily demonstrated, and although, no doubt, important in themselves, are particularly useful to us in our present view, as establishing the natural distinctions or boundaries between the columns which, descending from the encephalon, constitute the medulla oblongata and the spinal marrow.

I shall first name parts that are familiar, as being noticed in systematic works, and proceed to others which I conceive have been overlooked. Of the former class are the superficial transverse fibres of the pons or nodus cerebri, which, passing across, terminate in the crura cerebelli. When this part of the pons Varolii is raised, and with it the longitudinal striated matter which passes from the crus cerebri and is prolonged to the corpus pyramidale, a very distinct layer or septum of transverse fibres is seen crossing from the one hemisphere of the cerebellum to the other. This septum is best seen from behind, when the tracts which descend from the cerebrum and from the corpora quadrigemina are taken away.*

that undetached

As to those septa which I conceive have hitherto been neglected, the most remarkable is that which forms a plane in the median line, resting with its edge upon the last-named transverse septum, and extending its fibres directly backwards, so as to form a striated leaf, separating the two great longitudinal tracts which pass between the medulla oblongata and the thalami nervorum opticorum.†

If we separate the corpus restiforme (meaning by that term the mass which passes between the cerebellum and the medulla oblongata) from the corpus olivare, we shall find a layer of delicate fibres, which constitute a pellicle much resembling the fibrous layer, which might be peeled from the bark of the birch-tree, and this is a septum.*

---

* See the explanation of the last plate ~~but one~~ XI, Fig. 1. AA.

† Plate referred to above, Fig. 1. B.

Another septum of the same kind intervenes between the two anterior corpora pyramidalia. So accurately are the extreme anterior fibres of this septum attached to the corpora pyramidalia, that if we separate these bodies the fibres will alternately adhere to the right and left column, so as to present an appearance as if there was an actual commissure between them; and authors have mistaken this, describing that which truly is a septum of separation, as a bond of union. And so on the back part of the medulla oblongata, when we push aside the restiform bodies, or those columns which have sometimes been called the posterior pyramidal bodies, and open the central slit, we have the same appearance of minute commissures, which, however, is only the separation of the fibres of the plate or septum; and these fibres, instead of running in a direction to be a lateral bond of union or commissure, run from before backwards, and intervene between the longitudinal columns.

These layers not only distinguish in a natural way the columns which are descending from the cerebrum to form the spinal marrow, but they are necessary as leading us to the true points of union between the longitudinal columns, where their fibres actually decussate, and where these septa are deficient to permit the union.

The PONS VAROLII, or nodus cerebri, is undoubtedly an intricate part of the brain; but until this intricacy be explained, we can have no hope of making a correct arrangement of the course of the filaments in the brain, and which pass through this body. We shall therefore take it as a key to the composition of the brain.

---

* See explanation of last Plate but one, Fig. 1. CC.

The pons has with seeming correctness been considered as the commissure of the cerebellum. In this, its capacity of joining opposite parts, we have to notice its two transverse laminæ of fibres above alluded to, one superficial and the other deep-seated. We observe also an oblique lateral process which passes from the cerebellum to the crus cerebri. These septa intersect and distinguish the grand fasciculi or tracts of nervous matter, which, coming down from the cerebrum, seem to flow under the bridge and converge in the medulla oblongata.*

We commence our investigation with parts that are familiar. We trace the corpora pyramidalia of the medulla oblongata upwards from the point of their decussation towards the brain. They enter the pons by two distinct arches. The superficial layer of transverse fibres stretching from the crura cerebelli is over them, and the deeper septum is under them. On raising the superficial layer of the pons, we see the fibres of the corpora pyramidalia passing quite through to the crus cerebri; and now in one view we see a great portion of the grand tract which furnishes the nerves of motion.†

Let us divide these tracts by a transverse incision where the corpora pyramidalia enter the pons, and lift them up. We keep close to the deeper transverse septum, which we will find as distinct and smooth as a floor; and now directed by this septum we distinguish the portion of fibrous matter which is anterior to it; and if we follow this up into the crus cerebri, we shall come upon the corpus nigrum, and find that the crus is not a simple texture of filaments, but that it is compound, and that we are lifting that anterior division of it which belongs to motion, and which we shall find spreads over the tract of nervous matter which comes up behind the more deeply-seated septum. The soft and dark matter seen on making a section of the crus cerebri, divides the anterior and posterior tracts of columns.

---

* The terms pons and nodus are sufficiently intelligible and harmless, as implying no theory; I retain the old names unless the new ones be countenanced by the just eminence of the authors who have invented them. This is the proper check against the multiplication of terms in anatomy. In describing the course of the fibres, the expressions I employ are used in their anatomical sense, as implying the direction in which the hand and eye are following the line, and not in reference to the course in which I may suppose the energy to pass in the performance of their functions.

† See Plate of the Nerves of Motion, A, B, C.

We may complete our view of the motor tract, by making sections of the cerebrum, and pursuing the diverging fibres, first into the corpus striatum, and thence, as they proceed onwards, spreading into the hemisphere of the cerebrum and diverging to the cineritious convolutions.

Thus we have already found, that the crus cerebri is not simple, but consists of parts easily and naturally divided. Returning then to the pons as furnishing us with the means of making the natural distinctions of these tracts, we take the deep septum or posterior set of transverse fibres again as our guide, and trace,

THE POSTERIOR TRACT.

To obtain a distinct view of the whole extent of the posterior tract, we require to have the parts carefully prepared.* It will be very convenient to have the crura, pons, and medulla oblongata, detached from the great masses of the cerebrum and cerebellum, so that they may lie before us. We should first mark out and trace the columns of the spinal marrow; observing the corpora restiformia as they come down from the cerebellum, we may split them at the posterior fissure and fold them aside.

---

* It will be in vain for the anatomist to attempt demonstrating these facts in the recent brain; but he will find it easy if he take some old preparation of the brain, which has been for some years in spirits.

We now survey the extent of the fourth ventricle. On each side of the calamus scriptorius are two pyramidal columns.* To trace these upwards we must cut into the iter ad tertium ventriculum, by dividing the corpora quadrigemina, and then we can trace them up into the thalami nervorum opticorum. By a section we may trace each column through the thalamus, and then diverging into the corresponding hemisphere of the cerebrum.

Having followed these columns upwards, we next trace them downwards, and find that they join, intermingle, and decussate, and again separate, and proceed down the spinal marrow.

From no part of this column does any nerve of motion take its origin; its relations to the sensitive nerves will be seen on further dissection.

The corpus striatum and the thalamus lie very curiously together: the thalamus forms a nucleus round which the corpus striatum bends, and when their respective layers of striæ make their exit beyond these bodies to form the great fan or solar-like expansion into the hemisphere of the cerebrum, their rays mingle together. A rude representation of these two tracts of the cerebrum, as we have traced them, may be made with the hands. If I place my wrists together, parallel, and, closing one hand, embrace it with the other, I represent the two portions of one crus. The closed fist is the thalamus, and the other is the corpus striatum. If I then extend my fingers, interlacing their points, I represent the final distribution of the portions of the nervous matter which are dedicated to sensation and volition.

---

* In fact all the columns which form the medulla oblongata converge downwards and are pyramidal. We have the anterior pyramidal bodies, the posterior pyramidal bodies or corpora restiformia, and those deeper columns, whose form might authorize the term, as they are more especially counterparts of the true anterior pyramidal bodies.

But before proceeding further, we must distinguish a certain portion of the great tract of fibrous matter that lies behind the septum of the pons, which does not belong to sensibility, but to a different order of parts. If we dissect round the corpus olivare, we find it easy to separate this body from the column of motion on the fore part, and the column of sensation behind. Following then the fibrous portion of matter which ascends from it, we find that it runs close upon the back of the septum of the pons, and that a part of it goes off to the corpora quadrigemina, whilst a part runs directly into the crus cerebri.

On tracing the column which descends from the corpus olivare, we find that it is very soon attached to the columns both of motion and of sensation, and becomes incorporated with them as it passes downwards.*

We have now traced three great tracts or courses of fibres into the crus cerebri; an anterior one for motion, a posterior one for sensation, and a middle one, which for the present we may call the tract of the corpus olivare.

After these dissections, it is impossible for us to consider the medulla oblongata as the mere commencement of the spinal marrow: it has a peculiar structure and distinct functions; it is the body formed by the convergence of the great tracts of the cerebrum, where these tracts respectively meet and decussate; in it the tract of the corpus olivare is joined to those of motion and sensation.

---

* ~~Last~~ XII Plate, G.

Below the medulla oblongata the spinal marrow commences, or rather is prolonged from it, but it is constituted with a distinct arrangement of its columns. On each side it receives three columns from the cerebrum, besides those which come down from the cerebellum, under the name of corpora restiformia, to form its posterior part, and these columns enter into relations which do not exist above.

DECUSSATION OF THE POSTERIOR OR SENSITIVE PART.

We have noticed a fact of more than ordinary importance as reconciling the occurrence of symptoms, with our knowledge of anatomy. Where the posterior tract, descending from the cerebrum, has reached the point of the medulla oblongata, just opposite to the decussation of the corpora pyramidalia on the fore part, we described a coalescence. We have already stated, that when we proceed to separate the columns on the sides of the slit called calamus scriptorius, we see small, neat, and regular filaments, as it were, interlacing and joining the two columns. But when we examine further, we perceive that these filaments belong to a plate of fibrous texture which passes in the central plane from before backwards.* This striated septum stops or is interrupted by the union of the columns of sensation; and now attending to the fibres of these two columns, we find them to decussate with an interweaving as distinct as that of the corpora pyramidalia or anterior columns.† After this union and decussation has taken place, we may trace the nervous matter downwards in the two lateral portions of the spinal marrow, covered by the columns, which are the most posterior of all, and which descend from the cerebellum under the name of corpora restiformia.

---

* See explanation of XI ~~last Plate but one,~~ Fig. 1. B.

† Fig. 2. C.

Before tracing the origin of the sensitive roots of the spinal nerves, and that of the fifth nerve, in their relations to these tracts, we may review their course. We cannot fail to observe the remarkable correspondence in the structure and course of the two grand tracts or divisions of the crus cerebri, which descending, form so large a portion of the spinal marrow. Tracing them from the brain, we find both converging from the periphery of the hemisphere; both entering masses of cineritious matter, emerging alike, and approaching, but not absolutely joining; both contracting into narrow pyramidal columns; both having corresponding decussations, and only distinguishable at last by one of them giving origin to the motor nerves, and the other to the sensitive.

THE ORIGIN OF THE POSTERIOR ROOTS OF THE SPINAL NERVES, AND THEIR RELATION TO THE DECUSSATION OF THE POSTERIOR COLUMN.

The brain being before us so as to present its posterior aspect, and the back part of the spinal marrow, we raise the cerebellum and tear the pia mater, so as to expose the fourth ventricle. We may divide the processes of the cerebellum and take that body away. Having the parts thus prepared, we attend more particularly to the posterior series of roots of nerves which run towards the uppermost spinal nerve.

If we trace the line where the posterior roots of the spinal nerves arise, we find that the posterior columns of the spinal marrow are behind these roots; and if we trace these posterior columns upwards, we see them diverging under the name of corpora restiformia to the cerebellum. We strike a level by following the posterior roots of the spinal nerves into the spinal marrow. In doing this we shall find it necessary to lift the posterior column. Here we discover that layer of cineritious matter which is continued from the fourth ventricle in all the length of the spinal cord. Raising this coloured matter, we are able to trace the roots of the nerves; we shall find them connected with a course of longitudinal filaments; and these, on further investigation, will be found to be continued from the point immediately below the decussation of the posterior column of sensation, which I have described above.*

Thus it will be found that the posterior roots of the first, and consequently of all the spinal nerves, are derived from that posterior column which descended from the posterior division of the crus cerebri, and that they are thus placed in the same relation as the anterior roots with respect to the decussation of the prolonged medullary matter of the cerebrum.

THE ORIGIN OF THE SENSITIVE ROOT OF THE FIFTH NERVE, AND ITS RELATION TO THE SPINAL MARROW.

In former papers I have proved the fifth nerve of the head, according to the arrangement of Willis, to be the nerve of sensation to the head and face, thus distinguishing it from the nine nerves of the encephalon, and from the appropriate nerves of the senses to the nose, and eye, and ear.

---

* Fig. 2. C.

I gave my reasons, at the same time, for distinguishing it as the nerve of mastication, and shewed, in short, that it had all the characteristics of a spinal nerve. It becomes now a subject of interest to observe in what respect it further resembles the spinal nerves, and to inquire how its relations with the brain are formed. It is a happiness in this inquiry, that although it be difficult to trace the motor roots of nerves, owing to the delicacy of their connexions with the brain, the sensitive root is followed with ease into the brain or spinal marrow.

We commence the dissection of the fifth nerve by distinguishing its grand divisions as they emerge from the side of the pons, separated by a transverse band of fibres.*

Leaving for the present the scattered roots of the motor portion which pass between the transverse cords of the pons, we shall proceed to follow the other in a retrograde direction towards its origin. For this purpose, with a small and fine knife, we cut into the substance which surrounds the sensitive root, to the depth of the twelfth of an inch, and then lay aside the knife and take the curette, and perhaps the ivory handle of the knife.† With these we push aside the substance of the brain, in doing which there is no difficulty in distinguishing the smooth, flat, and ribbon-like white nerve. Continuing to press aside the matter of the pons, and, when separated, to cut it away, we find the nerve taking a course backwards and downwards into the medulla oblongata, making a considerable angle. Here we are interrupted by the crossing of the portio mollis of the seventh nerve.

---

* ~~Last~~ plate 5V ~~but one,~~ Figs. 6. 7.

† If we order dissecting instruments, there is no end to the trouble of procuring them fine enough. The operating case of the oculist, however, furnishes at once all that is necessary for delicate anatomy.

We observe in passing, that the portio mollis has two roots; that besides that usually described passing round the processus ad cerebellum to the anterior part of the fourth ventricle, it has a round root, which enters anteriorly to that process. But by attention and much neat dissection we may preserve these roots of the seventh nerve, and, recovering the tract of the fifth nerve below, trace it downwards. We are again interrupted by the origins of the eighth pair of nerves; and here, too, it will be found, on careful dissection, that this nerve does not correspond with the description in systematic works. But to proceed with our proper subject. Some part of the root of the fifth may be seen to deviate in a direction towards the calamus scriptorius; but the main tract descends behind the fasciculus of the corpus olivare, by the side of the great fasciculus of fibres which we have already traced down from the cerebrum. Disregarding this association, and following still the root of the fifth nerve, we find it continued to the roots of the superior spinal nerves; and in tracing it thus far, we must conclude that its relations are with the spinal marrow rather than directly with the brain, and that it joins the posterior column below the decussation of that sensitive tract or column. It remains a proper subject of inquiry to determine how far the deviation of a part of the sensitive tract of this nerve corresponds with its complex function in being the source of taste as well as of common sensibility.

It has been observed by diligent anatomists from time to time, that the nerves of the encephalon come off in a direction ascending from the spinal marrow. There can be no doubt that the sensitive root of the fifth ascends, and that it has its origin in the spinal marrow rather than in the brain. Without at present inquiring into the minute anatomy of the other nerves, we may draw very important conclusions from what is before us.

It is rather surprising, that from what was known of the anatomy of the brain, pathologists should have so agreed in their explanation of the phenomenon of injury of one side of the brain producing its effects on the opposite side of the body. Their opinion was founded on the decussation of the anterior columns, or pyramidal bodies, and those only; but great misconception must have prevailed as to the anatomy, when such an explanation could be satisfactory; and, at all events, it must have been believed that the posterior roots of the spinal nerves were the same, in function, with the anterior roots. When, however, it is understood that the anterior column of the medulla oblongata gives off only filaments of motion, the rationale of decussating fibres fails, or rather is imperfect; for, in injury of the brain, both motion and sensation are lost on the opposite side of the body. We perceive how important it was, in order to understand this symptom, that the posterior or sensitive part of this column should be shewn to descend from the cerebrum, and decussate at a point, corresponding to that at which the decussation of the pyramidal bodies takes place.

I have observed, that the corpus striatum is the part in which most frequently rupture of the cerebral vessels occurs; and the observations of authors correspond with this opinion. In such cases we can readily believe that the power of motion will be most injured; whilst such derangement in the hemisphere must, at the same time, more or less affect the sensibility.

Certain circumstances essential to the study of the pathology of the brain are explained through this part of anatomy: First, that motion and sensation should, in by far the greater number of cases, be lost together, in disease of the brain; because the sensorial extremities of both columns are in the hemisphere of the cerebrum: Secondly, it is seen why it is that the sensibility, as well as the power of motion, is injured on the opposite side of the body when the hemisphere of the cerebrum is hurt or diseased, for both columns decussate: In the third place, the anatomy of the origin or root of the fifth nerve explains very satisfactorily why, in palsy, the privation of sensibility of the side of the face corresponds with that of the body.

This paper should perhaps have terminated here, with these demonstrable facts, but I am tempted to reach a little further.

FURTHER EXAMINATION OF THE RELATION BETWEEN THE BRAIN AND SPINAL MARROW.

Other questions will be suggested in reference to the symptoms of disease in the brain. When the side of the body is paralytic, how far are the nerves affected which appear to have their origin above the decussations? Does the ninth or lingual, or the portio dura of the seventh nerve, correspond with the spinal nerves? Do the third nerve and the muscles of the eye partake of the condition of the body?

As there is no decussation above the apparent origin of these nerves, and as the commssiures of the brain do not serve to explain this phenomenon, we are directed in our inquiries to the spinal marrow.

The spinal marrow has much resemblance to the brain, in the composition of its cineritious matter, and in the union of its parts. In short, its structure declares it to be more than a nerve; that is, to possess properties independently of the brain. Another consideration presses upon us. Where are the many relations established which exist between the different parts of the frame, and are necessary to their combined actions? There must be a relation between the four quarters of an animal. If the muscles of the arm or of the lower extremities are combined through the plexus of nerves in the axilla, and in the loins, what combines the muscles of the trunk, and more especially what joins the extremities together in sympathy? That these combined motions and relations are not established in the brain, the phenomena exhibited on stimulating the nervous system of the decapitated animal sufficiently evince. They must therefore depend on an arrangement of fibres somewhere in the spinal marrow. Comparative anatomy countenances this idea, since the motions of the lower animals are concatenated independently of a brain, and independently of the anterior ganglion, which in some respects gives direction to the volition of these animals.

It comes next to be inquired, what use there can be in a decussation, by which one side of the brain is made to serve the opposite side of the body. Ingenuity can offer no reason for such an arrangement; the object must surely be an interchange of fibres, and consequently a correspondence in the movements of the sides of the body and of the extremities. And on this subject it must be admitted, that although in nine out of ten cases the side of the body opposite to that which is diseased in the brain is affected with paralysis, it is not always so, and very often a certain debility is perceptible in the side which is least affected. Again, when a man is seized with paralysis, he is sometimes affected with pain in the other side. These irregularities tend to countenance the belief that the decussations of the sensitive and motor spinal columns are rather intended to effect combination and sympathy between every part of the frame, than that one-half of the brain should belong to the opposite half of the body; and this for no apparent object, and without producing any harmony of action.

Such arguments induce me to believe that the brain does not operate directly on the frame of the body, but through the intervention of a system of nerves whose proper roots are in the spinal marrow, and that the decussation, or rather the arrangement of the fibres, takes place at the point where the columns descending from the brain join the spinal marrow, and consequently in effect above the origin of all the nerves, excepting those of the four senses. This supposition would furnish an explanation of the whole of one side of the body, limbs, face, and head, being similarly affected in paralysis. It would also explain the appearance, which all the nerves of motion and sensibility have, of coming in a direction upwards from the spinal marrow, rather than directly outwards from the brain, as the nerves of the proper organs of sense do.

In reflecting on the origins of the nerves of the encephalon, it appears that neither the nerves of sense nor those of motion arise from the cerebellum or its processes. It further appears that the restiform bodies or processes form no union or decussation similar to those which we have described in the columns of motion and sensation which descend from the cerebrum.

Those descending processes of the cerebellum, however, form a large portion of the spinal marrow; and we must thence infer that the cerebellum operates through the system of the spinal marrow.

The symptoms attributed to disease of the cerebellum do not remove the obscurity which invests this part of anatomy. We know that sometimes the whole hemisphere of the cerebellum is destroyed by suppuration, without loss either of sense or of motion. Moreover, when symptoms do attend disease of the cerebellum, its juxtaposition to the medulla oblongata inclines us to suspect that the effects are produced through the latter body. The substance of the cerebellum is not of diameter sufficient to have a large clot of blood in it, or a large abscess, without blood or matter communicating with either the fourth ventricle, or bursting out upon the surface. The influence thus becomes general on the nervous system, and a confusion in the symptoms is the necessary result. We have no distinct and well-marked cases of disease in the substance of the cerebellum, such as we possess of disease in the cerebrum; and on the whole it does not appear to stand in direct relation to the voluntary motions of the frame, or to the common sensibility.

ON THE RELATIONS BETWEEN THE

NERVES OF MOTION AND OF SENSATION AND THE BRAIN;

MORE PARTICULARLY ON

THE STRUCTURE OF THE MEDULLA OBLONGATA AND THE SPINAL MARROW.

From the Philosophical Transactions.

RELATION BETWEEN

NERVES OF MOTION AND OF SENSATION AND THE BRAIN, &c.

[*Read before the Royal Society April* 30. 1835.]

In this paper it will be necessary to enter on minute details of anatomy; but they regard a subject hitherto untouched, although essential to the comprehension of the nervous system; without which, indeed, it cannot be said that we have a knowledge of the nerves as a system.

The author having advanced by slow and laborious researches, from observing the general arrangement of the nerves as they lie in the body, to the investigation of particular nerves and their endowments; and, finally, to the examination of the parts in the centre of the system, the brain and spinal marrow, is now enabled to assign the reason of that perfect symmetry which reigns through the whole.

The subjects of his last paper have been examined again and again by dissection, and reviewed in every aspect. His statements have been found correct in every particular. But they necessarily lead to further investigation: they point more especially to a minute inquiry into the structure of the spinal marrow, and its relations to the encephalon on the one hand, and to the origin of the nerves on the other.

It might be imagined that the author of this paper had, in these inquiries, followed his preconceived notions; but it has not been so. On the contrary, when in search of the explanation of certain phenomena, he discovered a fact in the structure which diverted him from his design, and carried him in a new course of inquiry.*

In an anatomical investigation of so much delicacy, it is necessary, in order to understand the descriptions, that he who follows it by dissection should have the parts presented exactly in the same aspect, and trace them in a prescribed manner. After the anatomist has recognised the parts, and verified the descriptions of the author, he may of course vary his mode of proceeding to satisfy himself.

Lay a portion of the spinal marrow, of two or three inches, on the dissecting board, and pin it so that you look upon the posterior surface of that cord. Begin by making a clean transverse section of it near one extremity, and inspect the newly-divided surface. The first thing to be distinguished is the cineritious matter in the centre of the medullary. If we introduce the curette into the softer cineritious matter, we can separate the medullary columns, and we distinguish these parts: the posterior columns, deeply divided by their sulcus; the lateral columns; and the anterior columns.

In making these divisions, directed by the natural sulci and by the cineritious matter, we may soon satisfy ourselves that there is but one absolute bond of union by nervous matter. We find the anterior columns tied together by a sort of commissure, and to that commissure is attached the anterior portion of the posterior columns at two points.

Having contemplated the section of the spinal marrow, we proceed to the dissection by splitting up these co-

---

* The paper on the Voice was undertaken as a preface to the investigation of the accessory respiratory nerves. In following that subject, the author found it indispensable to deviate into this inquiry, which proves to be the more important of the two.

CONSULTATIONS AND CASES

ILLUSTRATIVE OF

THE FACTS ANNOUNCED IN THE PRECEDING PAPERS.

The following sheets refer entirely to the Nervous System. They contain notes of cases, and such letters of consultation as the author conceived himself at liberty to publish, confirming and illustrating the opinions delivered in the preceding papers. With other beneficial results, he hopes that they will tend to shew the importance of anatomy in questions the most strictly practical.

Systematic authors, possessing great learning, with the highest talents for investigation of disease, have, notwithstanding, run into much confusion in relation to the disorders of the nerves. Nor can this surprise any one who considers the obscurity that once prevailed respecting the nervous system, and the variety of the functions that were indiscriminately ascribed to the branches of the nerves from whatever root derived.

The author, wherever he could have recourse to the testimony of others, has preferred their words to his own. When an interesting case presented itself in the hospital, for example, he has been in the habit of desiring an intelligent pupil to make a note of it, without informing him of the object of the inquiry. This method of taking evidence as to matters of fact may have produced an irregularity in these notes; but it proceeds from the reverse of carelessness.

The reader may be disappointed with some very short notices of cases; but these are not *cases*, but notes of symptoms taken generally from the patient's mouth. It has been the author's practice to keep a note-book by him, principally for the purpose of making and preserving such jottings as might enable him to recognise patients on their return; and from this note-book these short statements are drawn and arranged, as contributions to a more accurate history of nervous symptoms.

with my dissections. The cineritious matter is not of a consistence or structure into which nerves can be traced: and through the whole column of the spinal marrow, up to the fifth and portio mollis of the seventh nerves of the head, the cineritious matter is superimposed on the columns and nerves.*

Between the lateral columns, the cineritious matter lies deep. Upon raising it, the anterior or motor columns are seen. In essential circumstances they resemble the lateral columns, and they are distinct from them. The cineritious matter occupies a portion of the space between them; and as to the remaining part, the line of separation is distinct, and the surfaces are unbroken.

By the manner in which the dissection has been made, the posterior portion of the spinal marrow being raised, as it were, out of the heart of the cord, the remaining parts fall flat, and the lateral and anterior columns separate.

Having distinguished the columns which form the spinal marrow, their natural sulci, their proper connexions, and the distribution of the cineritious substance between them, we have in the next place to observe how these columns are arranged, and what change they undergo in the upper portion of the cord, called medulla oblongata. We approach from below the same parts which we looked upon in their relations with the brain in the last paper.

---

* It is easy to trace the roots of the sensitive portion of the spinal nerve into the lateral column. It should be observed at the same time, that in raising the posterior columns, by insinuating an instrument into the cineritious intermediate substance, there is a more intimate attachment of the medullary substance of the posterior column at its outer edge and in the line of the origins of the nerves. It is not impossible, therefore, that the posterior column may be connected with the sensitive root of the spinal nerves, though hitherto I have not traced the fibres.

We must now have before us a portion of the spinal marrow with the medulla oblongata attached to it, and proceed with the dissection.

The parts being presented in the same aspect as before, we raise the two posterior columns, separating them from the others at the intervening cineritious matter. At the back of the medulla oblongata we find the posterior columns diverging, and forming the triangular space of the fourth ventricle; this space is laid open on tearing up the pia mater, which connects the cerebellum with the medulla oblongata. Each of these columns is now seen to consist of two; the outermost the larger, and that towards the central line the smaller, and in shape pyramidal.* Following up these diverging columns, we recognise them to be the processus cerebelli ad medullam oblongatam: these great tracts, which form a large portion of the spinal marrow, are now seen to bear relation to the cerebellum.

The posterior tracts or columns being raised, we have only the lateral and anterior columns, which belong to the cerebrum, to attend to. And here is the interesting part of this communication.

Once more observing the layer of cineritious matter, we brush it off from the lateral columns. This grey matter may be traced into the fourth ventricle, extending over the parts to be presently described, and over part of the roots of the fifth pair of nerves. It constitutes one sheet of matter from the cauda equina to the roots of the auditory nerves, and forms a grand septum between the anterior and lateral part of the spinal marrow which belongs to the cerebrum, and the posterior columns which are related to the cerebellum.

---

* This subdivision of what I have called the posterior column of the spinal marrow is to be traced in the whole length of the spinal marrow.

UNION OF THE LATERAL COLUMNS IN THE MEDULLA OBLONGATA.

On brushing away the cineritious matter from the cerebral portion of the spinal marrow, we recognise the two lateral columns. Upwards, or towards the brain, each of these columns has a double termination; first, in the root of the fifth nerve; and, secondly, in the union of the columns, or, in other words, in their decussation.

These columns lie separate in the spinal marrow; but having ascended to the medulla oblongata, they fall together, and form one round column something less than half an inch in length. On tracing this united column upwards they are disentangled, but do not separate, for they now constitute those processes of the cerebrum which, in a former paper, we traced down from the back of the crura cerebri.

On observing the portion formed by the united columns, the appearance is very much that which is presented by the union of the optic nerves; that is, however, rather when the part is thoroughly hardened in spirit: when it is somewhat more pliant, we can trace the filaments of one side into the column on the other side.* The decussation is the most perfect of any to be demonstrated in the brain and nerves.

Reverting to the statement in the former paper, that a septum divides the right and left sensitive tracts where they are seen in the fourth ventricle, and that in tracing that septum downwards it terminates at the point of decussation of these tracts; I have now to add, that the septum does not absolutely terminate; that it splits to permit the oblique course and decussation of the filaments of these columns. Thus separated at the union of the columns, the septa unite again below, and may be followed downwards into that connexion which binds the posterior portion of the spinal marrow to the anterior columns.

---

* Much of the anatomy, as I have here described it, may be made out in the recent parts. But it will be easier and more satisfactory, when the parts are soft, to drop them into spirits, so that the surfaces as they are exposed may be hardened and prepared for further dissection on a succeeding day.

It remains a desideratum to know what is the nature of those fibrous septa which intervene and divide the longitudinal tracts of nervous matter. But whatever may be determined on this point, it is obvious that they form a perfect link or bond of union and mechanical strength, extending from the pons to the cauda equina. Around the commissures the fibres of these bands are especially interwoven.*

When the two tracts or columns which descend from the posterior portions of the crura cerebri are transversely divided, where they form the slit of the calamus scriptorius, and when they are dissected down we obtain a very interesting view of the back part of the anterior columns, or rather of the pyramidal bodies, and their decussation. We see the union and decussation of these bodies before they separate and descend to form the motor columns of the spinal marrow. The motor and sensitive columns—which were close together in the crura cerebri, and which in their descent were separated in the pons, and by the septum which is continued down from the posterior transverse septum of the pons—come here again into contact at the point of union and decussation.* The motor columns approach the sensitive columns, but no union takes place; the columns keep their respective courses down the spinal marrow. When we dissect these parts carefully at the back of the medulla oblongata, we may feel, and with sharp eyes we may see, very minute, and yet uncommonly strong, filaments which run among these parts. We may consider such filaments as a further proof how carefully these textures are guarded against laceration.

---

* The true distinctions between the columns in the spinal marrow may be made, as we did those of the medulla oblongata, by observing the splitting of the septa. From the circumstance of the columns scaling off in regular pellicles, we may else be deceived. On separating, for example, the posterior and lateral columns at the true sulcus of separation, we shall see the minute transverse fibres: which appearance is produced by the splitting of the septum. See the former paper, p. 212.

When the dissection is carefully made, we have thus a view of the posterior part of the decussation of the pyramidal bodies; and, if we are tracing them downwards, after their decussation we see them separate and descend in the two anterior or motor columns of the spinal marrow.

CONCLUDING VIEW OF THE SENSITIVE AND MOTOR SYSTEM OF NERVES.

If it could be said hitherto that the distribution of the nervous system, more than any other part of the animal structure, evinces design, the conclusion is irresistible, when we perceive that the parts which minister to sensation and motion are arranged with a symmetry beyond what we expect to see in architectural plans or ornaments, where every part is balanced, and each has its counterpart.

It could not well be imagined that sensation and motion belonged to parts separate and dissimilar. Formerly I believed that the nerves of sensation, that is to say, the posterior roots of the spinal nerves, came from the posterior columns of the spinal marrow, and consequently from the cerebellum. Whilst entertaining this belief, I found my progress barred; for it appeared to me incomprehensible that motion could result from an organ like the cerebrum, and sensation from the cerebellum, for there was no agreement between them. They conformed neither in size, shape, nor subdivisions. Sensation and volition are necessarily combined in every action of the frame.* Although these influences, of whatever nature they be, are projected in different directions, and belong to distinct filaments,† they must be finally conjoined and in union. The anatomy conforms to this idea; the cords of communication between the seat of volition and the organs of the body proceed from a centre, run parallel, undergo similar changes, and are blended in their ultimate distribution, as in their central or cerebral relations.

---

* The motor and sensitive columns do not mix or decussate, but only the motor columns with each other, and the sensitive columns with each other.

It is pleasing to see that, through the labours of members of this Society, the principles which have directed the author in the investigation of the human anatomy are likely to be extended in their application, by a correspondence being observed in the arrangement of the nervous tracts through every class of animals possessing volition. It has long appeared to the author that the system does not differ, even in the different classes of animals, although there is much apparent variety in the distribution of the nerves.

When it became a question whether or not *Crustacea* possessed the organ of hearing the celebrated Scarpa undertook the investigation. With this purpose he did not pry about to discover the external organ of the sense: he looked to the brain or cerebral ganglion,—recognised the part from which the acoustic nerve should come, according to the analogy of other animals. He found the nerve, and traced it to its destination; that simple rather than imperfect organ, which, but for the circumstance of the auditory nerve in its cavity, might have been supposed too defective in its organization to be capable of receiving the impulse of sounds.

---

* This has been treated in former papers, and particularly in treating of the actions of the lips.

† See the paper on the Nervous Circle.

In this manner is the nervous system to be studied; for there is an internal change, in accordance with outward organization, whilst the system, or great plan, does not vary. There is an endowment in each particular column; it is one through its whole course. An animal, or a class of animals, may have a particular organ developed, and with the external apparatus there is a corresponding or an adjusted condition of the appropriated nerve. Another class may be deficient in the external organization, when we shall in vain look for the accompanying nerve; it is contracted, or hardly visible; but with all this the system is unchanged.

From a more cursory view of the comparative anatomy than others may have taken, this is my conclusion. But my time for such investigations has been given almost exclusively to the human anatomy; and there I hope it will be granted that the system, as it regards sensation and motion, has been displayed so as to increase the interest of these pursuits, and to direct the studies of the pathologist to beneficial results. Much advantage could hardly have been expected from dissection of the brain, even with the utmost ingenuity of research, whilst the very elements of the subject, as regards the natural anatomy, were unknown.

APPENDIX,

CONTAINING

CONSULTATIONS AND CASES

ILLUSTRATIVE OF THE FACTS ANNOUNCED IN THE PRECEDING PAPERS.

CONSULTATIONS AND CASES

ILLUSTRATIVE OF

THE FACTS ANNOUNCED IN THE PRECEDING PAPERS.

The following sheets refer entirely to the Nervous System. They contain notes of cases, and such letters of consultation as the author conceived himself at liberty to publish, confirming and illustrating the opinions delivered in the preceding papers. With other beneficial results, he hopes that they will tend to shew the importance of anatomy in questions the most strictly practical.

Systematic authors, possessing great learning, with the highest talents for investigation of disease, have, notwithstanding, run into much confusion in relation to the disorders of the nerves. Nor can this surprise any one who considers the obscurity that once prevailed respecting the nervous system, and the variety of the functions that were indiscriminately ascribed to the branches of the nerves from whatever root derived.

The author, wherever he could have recourse to the testimony of others, has preferred their words to his own. When an interesting case presented itself in the hospital, for example, he has been in the habit of desiring an intelligent pupil to make a note of it, without informing him of the object of the inquiry. This method of taking evidence as to matters of fact may have produced an irregularity in these notes; but it proceeds from the reverse of carelessness.

The reader may be disappointed with some very short notices of cases; but these are not *cases*, but notes of symptoms taken generally from the patient's mouth. It has been the author's practice to keep a note-book by him, principally for the purpose of making and preserving such jottings as might enable him to recognise patients on their return; and from this note-book these short statements are drawn and arranged, as contributions to a more accurate history of nervous symptoms.

CASES ILLUSTRATIVE OF THE DISTINCTION IN THE NERVES OF SENSATION AND OF MOTION.

No. I.

In Les Œuvres Posthumes de Pouteau, vol. ii. p. 481, there is a case (from the Memoires de l'Academie des Sciences) illustrative of this subject.

The patient was a soldier, thirty-three years of age. He was deprived of sensation in the left upper extremity, whilst motion remained perfect. He had a feeling of coldness in the arm, which was neither increased nor diminished by temperature, by holding his hands to the fire or by taking up ice. It happened that he lifted from the fire the cover of a frying-pan nearly red hot, and quietly put it in its place, without feeling that his hand was burnt, although the palm and finger lost the skin, and the tendons mortified from the effect. When the lapis infernalis was used, or incisions were made in his hand, he was insensible to pain. This loss of sensation had been preceded by pain gradually extending from the arm to the shoulder.

No. II.

Another case was witnessed by Pouteau himself, similar to that narrated above. The patient was fifty-two years of age. The insensibility had continued for twelve years. The left upper extremity, including the shoulder, was insensible to touch, while he could use the left arm in perfect conformity with the right. Pricking with needles, boiling water, incisions with the bistoury (made on account of a carbuncle on the shoulder), issues,—were attended with no pain. He had the misfortune to dislocate the elbow, but neither the accident nor the extension during reduction were attended with pain.

This author supposes sensation to result from the cerebrum, and motion from the cerebellum.

Haller's opinion is expressed, Phys. T. IV. lib. ix. § viii.

Le Cat supposed two fluids: a more subtile fluid coursing superficially on the nerve, and from its fineness giving rise to sensation; the other a less refined fluid, circulating through the tubes of the nerve, and bestowing motion.

No. III.

(The 16th June 1834. Note-Book.)—I attended a relative of Mr L., South Street, F. S. This lady had defect of sensibility first in the hands, then in the feet, at length in the whole body. She felt as if her clothes were falling off. She says that she feels as if walking in a pond of water. When she shuts her eyes she cannot direct her steps; nor can she grasp or take hold of any thing unless she sees it. This lady lingered and died. Mr A. Shaw with Mr L. carefully examined the brain and spinal marrow, but found nothing to account for the symptoms. Some thin scales, of a substance resembling cartilage, were discernible on the anterior and posterior surfaces of the spinal marrow.

No. IV.—*Case of Paralytic Affection, in which sensation was diminished on one side and the power of motion on the other.*

"My Dear Sir,—The case about which you have more than once expressed an interest was this :—

"Mrs W. was delivered by a midwife at Kilburn. Her labour was easy, but followed by profuse hæmorrhage upon the separation of the placenta, and after its exclusion from the uterus.

"She revived from the state of exhaustion immediately consequent upon the loss of blood, but at the end of about three or four days became feverish, and complained of severe headache: for a week, however, she had no other assistance than that of the midwife.

"At the end of this time (about ten days after her delivery), the headache continuing, and being now accompanied with some degree of 'numbness on one side,' I was requested to see her.

"I found her labouring under severe headache, not confined to, but infinitely more violent upon one side than the other, and occupying the region of the temporal and occipital bones above the mastoid process, attended with considerable pulsation.

"Upon one side of the body there was such defective sensibility, without, however, any corresponding diminution of power in the muscles of volition, so that she could hold her child in the arm of that side so long as her attention was directed to it; but if surrounding objects withdrew her from the notice of the state of her arm, the flexors gradually relaxed, and the child was in hazard of falling. The breast, too, upon that side, partook of the insensibility, although the secretion of milk was as copious as in the other. She could see the child sucking and swallowing, but she had no consciousness, from feeling, that the child was so occupied: turgescence of that breast produced no suffering, and she was unconscious of what is termed the *draught* on this side, although that sensation was strongly marked in the other breast.

"Upon the opposite side of the body there was defective power of motion, without, however, any diminution of sensibility. The arm was incapable of supporting the child; the hand was powerless in its gripe; and the leg was moved with difficulty, and with the ordinary rotatory movement of a paralytic patient; but the power of sensation was so far from being impaired, that she constantly complained of an uncomfortable sense of heat, a painful tingling, and more than the usual degree of uneasiness from pressure, or other modes of slight mechanical violence.

"Medicinal agents, including bloodletting, general and local; blisters; purgatives, &c. directed, first by myself, afterwards by Dr P. M. Latham, to whose care I directed her in the Middlesex Hospital, were of little avail, and she at length left the hospital, scarcely if at all benefited.

"At the end of a few months she again proved pregnant. Her delivery, at the full time, was easy and unaccompanied with hæmorrhage, or other formidable occurrence, but at the expiration of about ten days she complained of numbness on both sides. Her articulation was indistinct: she became more and more insensible, and sunk, completely comatose.

"Upon examination of the body no positive disorganization of the brain could be detected. The ventricles, however, contained more than usual serum; and there were found, more especially opposite to the original seat of pain, thickening, and increased vascularity of the membranes, with moderately firm adhesion in some parts; in others, an apparently gelatinous, transparent, and colourless deposit interposed between them.

"Such is the outline of a case which I have been in the habit of quoting in my lectures, as an illustration of one of the pathological conditions which I have repeatedly observed as a consequence of great and sudden loss of blood; and as a proof that it is a state of local congestion allied, if not amounting to, actual inflammation. It, however, obviously involves many other interesting points connected with those intricate subjects which you have so successfully unravelled. I am, dear Sir, yours truly,
H. Ley."

This illustrates the fact that the motion of the muscles is governed through a consciousness or perception of that motion. Indeed it can only be from a sense of the condition of the muscles of the hand and arm, for example, that we know the position they are in when there is no contact, and therefore no exercise of the sense of touch. The man whose arm has been amputated, has not merely the perception of pain being seated in that arm, but he has likewise a sense of its position. I have seen a young gentleman, whose limb I amputated, making the motion of his hands to catch the leg and place it over the knee, after the limb was removed, and the stump was for some time healed; so a man, who has lost his arm close to the armpit, has a perception of that arm changing its position. It is by this sense of the condition of muscular action that we are enabled to regulate the whole muscular system, and balance the body.

Several instances have occurred in which the paralysis of the lower extremities, succeeding scrofulous inflammation of the bodies of the vertebræ, was attended with entire loss of motion, but with very slight defect of sensation. This is attributable to the roots of the motor nerves being more immediately exposed to the inflamed bone.

No. V.

In the following excerpt from a letter of consultation, Mr Bailey of Thetford describes an affection of the nerves of sensation as opposed to those of motion.

" Mrs ——, aged 66 years, a lady of high respectability, consulted me in October last, in consequence of experiencing a numbness in the hands and fingers, which to her sensation felt as if some sand were interposed between them and the object touched. There was no want of power in the muscles, excepting a slight stiffness; as any substance could be firmly grasped. So impaired is the sense of touch, that it is with difficulty she can distinguish the object wanted: This is particularly the case when feeling in the pocket. With the exception of these sensations, her general health did not appear to have suffered. There is no pain complained of; the appetite natural; the digestive powers strong, and the alvine secretions perfectly correct; the pulse was regular as to strength and number of pulsations.

" In April last, I am sorry to say, the symptoms increased, and became extremely distressing; the fingers seemed more loaded than ever, and the difficulty to take from her pocket what might be wanted (from want of accurate touch) was more evident; with this a considerable tightness about the abdomen, extending round the back and up the shoulders and chest, was experienced, as if she were corded in different parts, rendering it difficult to turn in bed or rise; these same sensations affect the thighs and legs; which appear not to belong to her. With all these symptoms no pain is complained of."

No. VI.—*Note of a case, communicated by Mr Budd, of loss of Motion, Sensation remaining.*

A labourer's wife, æt. 41, was seized, while apparently in good health, first with weakness of the left foot, and, in five weeks afterwards, with weakness of the right foot. This did not prevent her, for some time, from walking with assistance, but gradually she was altogether deprived of motion in her legs, and was confined to bed.

It was remarkable that she experienced no diminution of the sensibility of the skin of the affected parts. Being unable to shift her position in bed, she suffered very much from the pressure against the points of bone in lying; and to get relief, she was obliged to keep one of her children always beside her to change her position. She wakened her child frequently in the night, to obtain her assistance in turning herself round. A flea bite distressed her, yet she could not move to scratch herself!

A year after the commencement of the complaint, the weakness extended to the arms, and she began to experience difficulty in her breathing. The accessory muscles of respiration in the neck and chest were then seen to act with remarkable force.

Her general health had been good until the paralysis reached the superior extremities, when she got gradually worse, suffering mostly from difficulty of respiration, and died in six weeks. No examination of the body could be obtained.

No. VII.

Mrs Stewart. The cause of her symptoms was an accident of extraordinary severity. At Brighton she had taken her seat in the coach for London, when the horses took fright and dashed the coach over the cliffs. She was taken out insensible. This poor lady suffered long from the shock to the spinal marrow; unsteady on her feet, and full of pains. The last faculty which has been restored is her natural feeling of heat; any thing moderately warm gave her the sensation of its being burning hot; at the same time that she did not *feel* what she touched. With the left hand, that in which she had most feeling and used the most, she could take up a jug with boiling water which her husband could not touch. There long remained the sensation of sand between the tips of her fingers and what she touched.

No. VIII.—*Note of a Patient seen with Mr Stanley.*

Numbness and insensibility of the left side, but no difficulty in moving; could run or ride. Has lost the feeling in both legs: when lying he could move them in every direction, but if his eyes were closed he did not know where his feet were!—" There was no motion I could not perform, provided I saw my feet." Cannot hold the child sitting on the knee; would let it fall. A taper seen with the left eye is like a distant star.

No. IX.—*Paralytic Affection of the Face.*[*]

Trismus diastrophe. Diastrophe Galeni. Oris tortura paralytica Linnæi. Est distorsio oris versus alterutrum latus, ob oppositi lateris hemiplegiam, unde musculus zygomaticus et buccinator lateris sani os ad se trahunt et tractum detinent, paralyseos aut apoplexiæ prodromus aut sequela: eamdem curam expostulans.—*Sauvages.*

In consultation the following letter was put into my hands:—

" It is in my power to relieve your mind of much anxiety. My experience has furnished me with five cases of paralysis of the muscles of the face of one side, completely local, and in no way connected with the *encephalon*. They all did well without general bleeding. Dr B. and Dr S. met me lately in consultation on the case of a lady in the eighth month of her pregnancy, who suffered this partial paralysis of the muscles on one side of her face, from the action of mercury on her mouth. The sore mouth inflaming, a lymphatic gland between the mastoid process and the angle of the jaw compressed a branch of the seventh pair of nerves. The muscles of the face on that side were so completely paralysed, that the cheek was drawn by their antagonists, and the mouth disfigured.

---

[*] To know the previous state of opinions, and the point from whence we start, read a paper on this subject, Transactions of the College of Physicians, vol. i.

"Dr B. and Dr S. suspected pressure on the brain at the origin of the fifth pair of nerves. But I took the liberty of stating the discoveries of Mr Charles Bell, and proved to them by other cases which had fallen under my notice, that there was no danger, and that the brain was not implicated.

"This case, in the course of a fortnight, did well under the use of mild laxatives, leeches behind the ears, and a small blister."

No. X.—*Case of Paralysis of the Face.*

I owe the following case to the kindness of Dr Gregory, who has vouched for the accuracy with which the account of symptoms has been drawn up by a medical friend. The patient was at the time under Dr Gregory's care.

"John Chapman, æt. 45, foreman to a builder, January 1827. He says, for five years past he has not considered himself in a good state of health. Three years ago, after a few days' illness, he was seized with paralysis of his lower extremities: he recovered from this attack, and resumed his occupation. He had an abscess in his right ear, which burst, and continued to discharge matter: he cannot precisely state when the disease of his ear commenced. For eighteen months following the attack of paraplegia, he was subject to fits of the ague; afterwards he was free from any complaint, except that his ear discharged a thin fœtid matter. In August last, while coughing or sneezing, a substance which he describes as cylindrical and hollow, about an inch in length, dropped from his right ear: from this time the discharge ceased. Three weeks after this period, his wife first observed that his face was distorted to one side. On presenting himself to his medical attendant in the country, he was told that he was going to have another attack of palsy, and was ordered to be cupped and blistered, &c. His daughter says, his countenance appears now exactly in the same condition as when first observed to be distorted.

"All the muscles of the right side of his face, which are controlled by the influence of the portio dura, or respiratory nerve of the face, are completely paralyzed. He cannot elevate his eyebrow nor frown; there is a line nearly in the centre of his forehead, dividing the bulging of the muscles on the left side from the smooth uncontracted state of those on the right side. He cannot close the eye-lids of the right eye; they remain always open: when he makes the attempt to close them, we see the eye-ball rolling upwards. The secretion of tears is very abundant, so as to render this eye more glistening than the other: he complains of the inconvenience produced by its continually weeping; he also attributes a dimness of vision in the right eye to this cause. From the nature of his occupations, he is constantly troubled by the dust getting into this eye; but he has acquired a readiness of pulling down the eye-lid with his finger, to defend it. His daughter says, that when she has seen him sleep, only the white of his eye was visible.

"His right nostril is collapsed. The muscles of the cheek and mouth are relaxed and dragged to the left side. When he speaks, the cheek flaps like a blind before an open window, and if he attempt to utter a word with peculiar emphasis, the air escapes from the corner of his mouth, like the whiff of a person smoking. He sometimes experiences a difficulty of swallowing, at the moment when the morsel is thrown back into the fauces.

"The sensibility of the right side of his face is natural. When he clenches his jaws, the masseter muscles can be felt equally hard and contracted on both sides of his face. He can protrude his tongue, and twist it to either side. He is deaf in the right ear."

¶ The peculiarity of the preceding case is in paralysis occurring in two instances in the same patient, but from different causes. It was natural for the physician in the country, on perceiving paralysis come upon the face, to suppose it was the precursor of a second attack of paraplegia. But comparing the symptoms with those of other cases in this Appendix, and more especially observing the connexion betwixt the discharge from the ear and the paralysis of the face, the reader will be inclined to believe with me, that the second attack arose from the affection of the portio dura in its course through the temporal bone.

No. XI.—*Clinical Lecture on partial Paralysis of the Face, delivered by Sir Charles Bell, at the Middlesex Hospital.*

CASE.—Daniel Quick, æt. 70. One of the young gentlemen attending the hospital brought this old man to shew him to Sir Charles Bell. He had observed him sweeping the streets: one of his eyes was staring wide open, and red: the cheek on the same side was loose and pendulous, and the mouth was dragged to one side. His attention being attracted by these appearances, he was led to question the man as to the cause of them.

Twelve years ago his face was "all right;" but, he said, pointing to a scar in the angle of the jaw on the left side, ever since he received a wound in that part, from being tossed by a bullock, his face has been in the same condition in which it now is. The horn of the animal had entered his neck just below the ear; he was lifted from the ground, and when he fell, the blood gushed out, according to his expression, " as when a sheep is stuck." A surgeon sewed up the wound, and " made a capital cure of it."

The left side of his face forms a remarkable contrast with the other. Upon the forehead the skin lies flat and smooth, there being no wrinkles as on the right side; and when he frowns, the left eye-brow moves only a little, by the action of the muscles on the right side dragging it towards them. The eye remains permanently open: there are none of the common winking motions: and when he is asked to close the eye forcibly, although he makes the attempt, there is not the slightest motion observed in the eye-lids. The lower eye-lid hangs down considerably, so that the conjunctiva is much exposed; and there is a fulness in its vessels, apparently consequent on repeated attacks of inflammation. This eye has been the source of great distress to him, especially during the summer season, owing to the dust and the brightness of the sun both injuring it. His wife, he said, has told him that he never closes this left eye, not even when he is asleep. In the repeated attempts which he made, although the eye-lids did not move, it was always observed that the cornea was tilted upwards, so as to be completely concealed behind the upper eye-lid. This is a motion of the eye-ball which Sir Charles Bell first described in his papers upon the nerves within the orbit; and he has on former occasions pointed it out to the pupils at this hospital. Being curious to discover the position of the eye during sleep, the reporter of this case went to the patient's house. His wife told him, that what her husband said about his never closing the left eye was correct, and that it was open even while he was sound asleep. Being then asked in what direction he appeared to be looking while he was asleep, whether he fixed his eyes on her? " No, sir," she said, " that cannot be, for there is only the white of his eye seen." Being further questioned, she said, that a small part only of the black of his eye could be perceived, at the margin of the eye-lid; but she was quite sure he could not see her.

The muscles of the cheek on the left side are wasted, and there appears to remain nothing but the thin integuments, which hang upon the side of the face, as if dead, without having any action in them, or wrinkles, as in the right cheek; and when he speaks, this cheek is alternately puffed out and then collapsed, the air first distending it, as it were a bag, and then escaping at the angle of the mouth.

The left nostril lies flat, and is not at all distended while he draws a deep breath, or makes the motion of sniffing up.

His whole mouth is drawn to the right side, thus producing most remarkable distortion of the face. Whatever action there is in the mouth, is altogether owing to the contraction of the muscles on the right side of it; the left angle hangs loose, and is quite passive; and the saliva is allowed to flow constantly out upon the lower lip on this side.

In regard to sensation, that is wanting only in the integuments over the cicatrix, and a little way above it, just before the ear. Otherwise, in all the parts of the head and face, it is quite perfect.

Gentlemen, I have brought this man to you, that you might yourselves examine him, and be satisfied as to certain facts, which men, high in science, and respectable in our profession, have denied with a heat and pertinacity which I can never understand, and which surely ought not to belong to such an inquiry.

For years I had the conviction that the nerves, and especially the nerves of the face, had distinct functions. I was deterred from announcing my opinions, because I conceived it impossible but that experience and observation must have long ago ascertained the fact. Yes, gentlemen, from the dissection, I conceived that the branches of the fifth nerve, and of the portio dura of the seventh nerve, must have distinct offices. But then, I said, if it were so, the fact could not be so long concealed; these nerves are cut by surgeons every day; they are exposed in wounds; and yet I find no surmise to countenance this idea. Were I to refer to my note-books, I could prove to you how anxiously I looked around for some circumstance to support this opinion; and although of late years many such cases as the present have been submitted to me, there was a time in which I would have given all that I was worth to have had such proofs as you have now before you.

Some will contend about the propriety of making experiments on the living—none will hesitate to say that it is our duty to observe accurately when an accident may be converted into an experiment. This poor man was tossed by a bull: the horn went in here, at the angle of the jaw, and he hung suspended upon it, until the integuments before the ear giving way, he dropped. The blood flowed copiously, and he will tell you he heard it splashing upon the ground: notwithstanding, he expresses, with gratitude, that his doctor made a famous cure of it. The point of the horn had entered behind the upright portion of the jaw, and had hooked up and torn across the portio dura of the seventh, where it comes forwards from the stylo-mastoid foramen. I wish you to direct your whole attention to the effects of the division of this nerve; since it is as much of the nature of an experiment as if you had tied an animal neck and heel, and had divided the nerve with your scalpel.

You have observed the remarkable distortion of the whole face; and that one side is become, as it were, a dead mass, incapable of motion or of expression of any kind; an effect which, heretofore, any medical man would have supposed could only be produced by the division of all the six nerves that go to the side of the face; whereas you see that the effect has been produced by the destruction of one only. You observe, by the answers to my questions, that whilst motion is gone, sensibility remains. And you cannot resist the conviction that the remaining sensibility is owing to the entireness of the branches of the fifth pair, which come out through the orbit, and through the upper and lower maxillary bones; whilst the loss of motion has resulted from the tearing of the portio dura. Nor is this a solitary case in this hospital. A patient was brought in who had put a pistol to his ear; which, strange to say, did not immediately destroy him, nor at once deprive him of sense; although ultimately he died. The temporal bone was shattered, and the portio dura torn: and the paralysis of the muscles of the face was as complete as it is here.

[Sir Charles Bell.—Now, my friend, shut this left eye.

Patient.—No, sir, I cannot do that: my wife says I never shut my eye.

Sir C.—But make an attempt: close both your eyes, as if you were going to sleep.

The patient makes the attempt, but still adds—it is needless; "my wife says I never shut this eye." In the attempt, we observed that, when the eye-lids were closed, the left eye-ball was rolled up, so as to be concealed under the upper eye-lid.]

Sir C. continued—You witness the fact, then, gentlemen, that there is this very remarkable turning up of the cornea in the attempt to close the eye-lids; and you comprehend how this takes place. The imperfection is only in the eye-lids; and although the will cannot reach them, owing to the division of the portio dura, yet the rolling of the eye is performed, because the nerves to the oblique muscles within the orbit are entire. Before you, then, there can be no denying this revolving of the eye; in future you will allow no question about it.

If you will take the trouble to inquire, this man will tell you that he is not at all aware of the eye being turned up; although he can turn it up by a voluntary act, and be conscious of it at the same time. This is altogether an instinctive or involuntary action in the eye-ball; and you do not observe it in the ordinary case, merely because it is a part of the protecting action accompanying the rapid closing of the eye-lid which conceals it. You may, however, feel it at any time, by putting your finger gently upon the closed eye-lid; and then, acting with the eye-lids to close them more firmly, you will feel the convexity of the cornea slip upwards: or, spread out the eye-lid upon a friend's eye with your fingers, until you see the cornea under the tense skin: then ask him to make the effort to wink, and you will see the convex body slip up and disappear.

Without going far into this question, I would just observe that this motion is altogether for the protection of the eye: And you see that there are two parts of the same action; first, the dropping of the eye-lid, like a curtain; secondly, the raising of the cornea towards the lachrymal ducts; by which these ducts are stretched, and a copious secretion bedews the cornea.

The cutting of the portio dura, or of that branch of it which goes towards the eye-lids, paralyses the orbicularis palpebrarum, and the eye-lids therefore remain open. This has a very bad effect, by causing inflammation of the eye. In this case, you perceive the effects of this inflammation, in the eversion of the lower eye-lid, and the redness of the tunica conjunctiva—the circumstance, indeed, which first attracted our friend's attention to this man on passing him in the street. But the cornea is still safe; and you see how this is: although the eye-lid does not descend, yet the eye ascends to the eye-lid: and it is wiped, cleaned, and moistened, by this partial performance of the instinctive act of winking. We have had in this house a girl in whom the eye-lids of both sides were so adherent to the eye-brows and cheeks, from a burn, that they were not recognisable from the common skin. The eye-balls stood out naked; and although the horrible and preternatural appearance of the girl, consequent upon the staring eye-balls, was increased by the red circles of inflammation around them, yet the corneas were preserved transparent, by their being raised in the frequent act of winking, and dipped, as it were, at the lachrymal fountain. In the case before you, although the eye is not altogether destroyed by inflammation, you see the very unpleasant effects produced by the deprivation of this branch of nerve, in the exposure, inflammation, and suffusion of the surfaces.

The next thing that is curious is the condition of this man's eye in sleep. You find it stated that the cornea goes up during sleep; for his wife being asked, whether, since the eye-lid remained open, he continued looking at her when asleep, she answered, "that cannot be, for only the white of the eye is seen." You have here, then, all but ocular demonstration of what I have elsewhere affirmed, that there is a particular position of the eye-ball, or, in other words, another condition of the muscles of the eye-ball, peculiar to the state of sleep. Indeed, it must be obvious to you that if in this man the pupil were not covered, and the cornea moistened during sleep, there would be an incessant irritation upon the eye, from the entrance of the light, and the evaporation of the moisture from the cornea. But, however interesting in a philosophical light, this is not practical; and, therefore, I am not at liberty to detain you longer upon it in this place.

[Sir C.—Now, my friend, let us see you take a snuff—(the patient put the pinch to the right nostril). But why do you not snuff with the left side?

Patient.—Because it does not go high enough to let me feel it.

Sir C.—Can you breathe through that left nostril?

Patient.—My wife says I cannot.

A bottle of carbonate of ammonia being put to this nostril, he said, with some emphasis, "I can feel that."]

You see, gentlemen, that this honest fellow bids fair to have domestic peace: he confides more in his wife's authority than in his own sensations. But you will have no difficulty in understanding how the destruction of the portio dura affects the sense of smelling, and destroys, in a great measure, the gratification of snuffing. The cartilages of the nose form a very curious structure; and, you know, are moved by four appropriate muscles, these muscles being governed by the respiratory nerve of the face or portio dura. Every violent inspiration is attended with an excitement of these muscles, and an expansion of the tube: were this wanting, you see what the effect would be. At the moment of a sudden inspiration, instead of the tubes for the passage of the air being enlarged proportionally, they would hang, like this man's nostril upon the left side, which, you see, forms a loose membranous slit; and be more apt to close and cause a sniffling, in drawing the breath, than to become inflated to admit the air freely. In smelling, or in snuffing, there is such an action of these muscles as to produce both a narrowing and a new direction of the lower part of the tube of the nostril; by which the air, and whatever that air has suspended in it, is drawn forcibly upwards to the part of the Schneiderian membrane where the olfactory nerve is expanded. Our friend here finds it a mere waste of snuff to put it into this nostril: he tells you it does not go high enough: he can draw it in, but he cannot make it mount. You perceive, then, that although the function of the olfactory nerve remains entire, the loss of the portio dura is attended with a destruction of that apparatus which is made subservient to the organ of smelling.

[Sir C.—Do you put the morsel into the left side of your mouth?

Patient.—Yes; but I *wumble* it over to the other side.

He now got a pot of porter, and, as he swallowed, there was a flapping of the paralyzed cheek; he said that he required time, or it would fall out of his mouth again. Sir Charles thought he felt a stringy or active condition of the buccinator, but recommended us to give him a pot some other day, and ascertain this.

He was now asked if he could laugh; and, quaintly enough, he answered, " Yes, when he got something to laugh at;" and on this he exhibited a very singular distortion of countenance: at each cachinnation his left cheek was puffed out, flapping like a loose sail; and the forehead and eye-lids of this side remained perfectly still; whilst upon the right side the whole mouth was drawn upwards, the cheeks were strongly wrinkled, and the eye-lids puckered.]

You know, gentlemen, that I have classed the portio dura of the seventh pair with the superadded respiratory nerves; as, besides having the voluntary power over the muscles of the face, it produces that consent among them with the organs of respiration, which continues when the voluntary power is gone. And as this portio dura takes its circuitous course, for the purpose of associating parts necessary to the act of respiration, for the same reason it must be the nerve of expression; since the self-same parts are the organs of expression and the organs of respiration. Suppose that a filament of the fifth had been the link of connexion to establish the sympathies among the features of the face (as it was once supposed that its ganglion was for that purpose), then the nerve of motion in the face would have been separated from the other parts of the organs of respiration, and, consequently, from expression. You witness, however, in this patient the fact: you see that, with the destruction of this nerve, the expression in laughing is gone from the side of the face. You will, perhaps, take it on my authority, that crying would be all on one side of the face too. The neck, shoulders, and chest, would be equally incapable of agitation in laughter or weeping, if the respective nerves of this class were divided. Now these are the extremes of expression; and all the intermediate gradations, which are the signs of emotion, are frequently lost.

This subject is not uninteresting to you in practice; for as you find the portio dura in possession of distinct properties, all of them related to respiration—breathing, speech, and expression; you will not be surprised that these functions should occasionally be differently affected; as, for example, a man will continue to possess the power over the nerve, as the nerve of speech, and yet he will be incapable of expressing the usual signs in laughter or in crying. In short, you find that your patient sometimes exhibits paralysis of the side of the face only when he smiles or laughs; at other times it is not observable. We really have no reason to conclude that the one property of a nerve requires a finer organization than another. I should rather suppose that this power of expression is constituted with a finer relation to the condition of the mind and of the body; and, therefore, we may suppose is more easily affected by slighter derangements.

No. XII.—*Case of Spasm in the Muscles of the Face.*

Daniel Tooney, æt. 34, a bricklayer, was sent by a medical gentleman to shew himself to Sir Charles Bell. The right side of his face is affected with a remarkable twitching of the muscles, producing a tremulous motion of all the features, which, from being almost incessant, gives him great distress. It varies in its intensity, the contractions being occasionally more rapid in their succession, and more violent, than at other times: and it sometimes ceases, but only for a short time. The nostrils, mouth, and eye-lids, are all put into motion simultaneously; and the action cannot be restrained by squeezing the parts. While we were examining him, the motion ceased for a little. He is made aware of its beginning again, by a slight catching sensation behind the ear; it is also brought on by speaking; and is more violent if he is excited or angry.

It was observed that both the ear and the hair at the back of the head participated in the motion.

This complaint has lasted for four years. It commenced when his mouth was sore from taking mercury for a sore on his wrist. It is so distressing to him, that he is willing to submit to any operation that may remove it. He has no imperfection in his hearing: his health has been apparently good. The effect of a firm compress before the ear, was recommended to be tried; also a stimulating liniment over the nerve, where it emerges from the stylo-mastoid foramen. And he was ordered a pill of aloes and blue pill to be taken every night.

No. XIII.—*Proposal to divide the Portio dura.*

"Sir,—Having attended your brother's lectures during my studies in Edinburgh, and read several of the works of both, I am induced to apply to you in behalf of a very respectable patient, Mr —— of this place. He is a healthy strong man of fifty, who has been affected for nearly twenty years with an involuntary contraction of the muscles of the side of his face, drawing up the angle of the mouth, and giving to the palpebræ a winking motion, so remarkable, that it may be seen at a considerable distance. This hurts his feelings so much, that he has lately come to the determination of having an operation performed on the nerves of the part affected.

"He has never had any pain during the convulsive actions but once for two or three days, when it was so severe as to resemble, in many symptoms, the *tic douloureux*. I am ignorant that the operation has been ever performed for such an affection. But as the disease has become much more troublesome, I should think there would be no impropriety in trying it.

"Should you be enabled to give any encouragement to its performance, he will proceed to London immediately."

Remark.—In a note on the following page, it will be seen, that a gentleman came to me to have the branches of the fifth nerve, on one side of the face, cut, in order to balance the paralytic features of the other. A singular consequence would have resulted from such an operation. The patient would have been deprived of sensibility on one side of his face, and of motion on the other!

If the subject of the present consultation had submitted to have the nerve cut, his eye would have remained open, for the *attollens palpebræ* being supplied by the third nerve, and the *orbicularis palpebrarum* by the seventh, the cutting of the latter would have paralysed the eye-lids: they would have remained open, and the eye would have become inflamed, and probably opaque. There would have been greater deformity, and blindness also.

How such proposals are made is obvious enough. Surgeons have been, of late years, cutting the branches of the fifth pair with impunity; that is to say, no ugly paralysis resulted from these operations.

Answer to the foregoing Letter:

"34 *Soho Square, May* 16.

"Dear Sir,—I am happy you have communicated this case of Mr —— to me, for some serious considerations present themselves, before attempting to remedy his symptoms by an operation. The nerve affected is the portio dura of the seventh pair, which comes out before the ear, and spreads from that over the face. It is very liable to the affections which you describe. But before dividing it we must consider its functions, which are very important: through it, we are enabled to close the eyelids, and through it we move the lips in speaking. Although we leave the branches of the fifth pair going to these parts, yet, by the division of this portio dura of the seventh pair, we deprive them of all motion. The effect upon the eye is very serious: it remains open, and the exposure excites inflammation and opacity.

"These, you will see, are strong reasons against cutting across the nerve. Perhaps you are not aware that the dividing of this portio dura would not at all diminish the pain, the sensibility of the side of the face depending altogether upon the fifth pair. I fear, therefore, you must limit your attempts to relieve your patient by medical treatment. You will find this twitching to depend a good deal on the state of the digestion. Anodyne liniments rubbed in the course of the nerve, and pressure to limit the motion of the parts spasmodically affected, I have found attended with advantage. The pressure, which restrains this spasmodic motion, tends to break that habit, on which, in a great measure, it at length depends, however originally produced: and indeed it is this circumstance, the continuance of the symptoms for twenty years, which forbids me being sanguine in the expectation of your effecting a cure.

"Charles Bell."

No. XIV.—*Proposal to divide the branches of the Fifth Pair.*

A gentleman, in the vigour of life, came into my room to consult me, having the most remarkable distortion of countenance I had ever seen. He proceeded to state to me what he conceived to be the cause of this paralytic affection of one side of his face: he had been knocked down by a blow upon the ear, and had remained a whole night insensible, with bleeding from the ear, from which time his features had been thus drawn to the opposite side. I thought I should give him comfort by stating to him that this was a paralysis attributable to the injury of the bone, and that, as it had not proceeded from an apoplectic tendency, there was no danger of a future attack, or of increase of the paralysis. But this was not what he expected from me; he had consulted my brother, then at Rome, who had proposed to cure him by an operation.

I was quite at a loss to conceive what operation my brother's ingenuity had contrived to relieve so remarkable a deformity. The gentleman mentioned that it had been intended to make three small incisions on different parts of his face, so as to restore the balance of his features: and he was obviously disappointed in finding me less intelligent, or less able than he had expected, and we parted.

On reflecting on the conversation of this gentleman, it occurred to me, that my brother, believing that the paralysis had arisen from an injury of the fifth nerve, had proposed to restore the features to an equilibrium by dividing the branches of the same nerve on the opposite side; trusting, no doubt, to the features being still animated by the seventh pair of nerves, according to the received doctrine. A singular consequence would have resulted from such an operation. The features would have remained drawn to the same side as before, and he would have been deprived of all sensibility of that side! If it was designed to cut the *portio dura* of the side contracted, a more unhappy consequence would have resulted; for he could never afterwards have spoken, or even have kept his lips to his teeth, or retained the saliva. The features of both sides would have fallen in relaxation; the eyes would have remained uncovered; and he would have lost his sight by the inflammation and opacity consequent on their continual exposure!

It must, indeed, appear a singular circumstance now, that so many surgeons were cutting the branches of the fifth pair of nerves for the tic douloureux, without being led to inquire more particularly into the functions of the several nerves of the face. We see how nearly my brother's ingenuity had led him wrong, from having often cut the fifth pair without producing horrible distortion. And I believe that the very same mistake led a gentleman to say that I had not cut the frontal branch of the fifth pair of nerves on the face of a nobleman, when in fact I had only cut that branch, and had not interfered with the branches of the *portio dura*, and, consequently, had produced no effect on the muscles of the eye-brow. All these circumstances, I hope, tend to enforce the importance of anatomy.

No. XV.

I find the following observation in a review of a former edition of this work:—" It would appear that Mr Bell has not consulted Dr Darwin's Zoonomia: for we find there a striking illustration of his opinion. A gentleman having tic douloureux was under the care of three eminent practitioners, Dr Darwin, Mr Cruickshanks, and Mr Thomas. Nine incisions (together with some smaller ones) were made on the left side of his face: every nerve of that side of the face, including the branches of the fifth pair and of the seventh, were divided; yet there is not one word concerning the defect of sensation or of motion. The patient set out for Leicestershire perfectly restored."

No. XVI.—*Paralysis of the Face.*

"My dear Sir,—Being informed by Mr Alexander Shaw, that you were desirous of having some notes which I had taken of a case of partial paralysis of the face, I beg leave to transmit them to you.

"S. Nicholas, æt. 35, a sailor.—He has been ill for upwards of three years, with various scrofulous affections. Two years ago, he first noticed that he was deaf in his left ear. Subsequently there has been a discharge from it. About nine months ago, abscesses formed in various parts of his body, one of which broke just betwixt the mastoid process and the angle of the jaw of the left side. The cicatrix is still painful to the touch. Shortly after the formation of the abscess, it was remarked that the left side of the face was paralysed, and the eye-lids of the same side stood open, and could not be closed by any mental effort directed immediately to them.*

"He says that a portion of that side, viz. the fleshy part of the cheek, feels puffy, although he adds, he is conscious that this is not really the case. The left ala nasi is also paralysed, for if he lies on the right side with his head pressed against the pillow, he is obliged to pull the left nostril open with his fingers in order to breathe freely.

"He also says, that he feels as if he had no power to hold any thing with the *sound* side of his mouth. It is certain that he always applies the mug, in drinking, to the paralysed side.

"He can chew equally well on both sides. And the sensation of touch is equally acute in all parts of his face. The eye-ball of the left or paralysed side is also sensible to touch and to other stimuli. The motions of the eye-ball were examined by Mr North of Seymour Street, by Dr Stewart, Mr Griffiths, and by myself, and it was evident to all of us, that whenever the patient attempts to close his eyes, the left eye-ball is turned up. When the right eye-ball was examined by forcibly separating the lids of that side, it was always found in the same position as the left. I remain, dear Sir, your obliged, R. Ferguson.

"Feb. 21. 1825.
"5 Baker Street, Portman Square."

We have, in the foregoing letter, a simple and very clear statement of a common case. For the case is very common, although the observers are not always masters of the subject like Dr Ferguson.

The *rationale* is obvious enough. The *portio dura* is involved in the stool of an abscess; and it has partaken of the inflammation. Just as the spinal marrow being involved in the inflammation of the diseased vertebral column will cause paralysis of the lower extremities, so here the muscles of the face corresponding with the *portio dura* lose their power.

---

* It may be worth remarking, that Nicholas always keeps the lids of the left eye closed by his hand, to keep it warm, as he says.

The reader will observe, that the patient "*can chew equally well on both sides.*" I have noticed such circumstances before, that although the individual could not hold his pipe with the lips, he could turn the morsel, which led me to reflect on the muscular branches of the fifth pair sent to the buccinator muscle, and the levator and depressor anguli oris.

In the preceding letter, as well as in several which follow, notice is taken of the rolling of the eye-ball. I have explained the necessity of a connexion between the motions of the eye-lids and the motions of the eye-ball itself; and I have shewn that the connexion between the muscles of the eye-lids and eye-ball is established at the roots of the seventh and fourth nerves. I may be permitted to express my surprise that there has been any doubt upon this subject: it is so easy to prove that when the eye-lids close, the eye-ball rolls up.

In reference to the last case, it is distinctly stated, that when the eye-lid stood open from paralysis, the eye-ball turned up at every effort to close the eyes. Systematic authors call this want of power to close the eye-lid, *Strabismus lagophthalmos; Vue de lièvre,* from the vulgar notion that the hare sleeps with her eyes open.

Sauvages says, that this affection is classed with strabismus; but on what principle, he adds, authors have failed to inform us. I believe it is owing to the eye-ball being seen turned up, which is conceived to be part of the disease; but this is a natural action, which, from the eye-lids being apart, is visible, and appears symptomatic of disease.

On every occasion where the immobility of the eye-lids has given me the opportunity of observing the motions of the eye-ball, it has rolled upwards, as I have described, during the effort to close the eye. I have many times pointed out the circumstance to the pupils going round the hospital.

Sir D. Brewster, in his Journal, denies that the eye-ball revolves. There can, however, be no doubt of the fact. The object of the first paper on the motions of the eye, was, *first,* to shew the different motions of the eye-ball and eye-lids, and to deduce from that examination the necessity of two classes of muscles: *secondly,* to shew that the muscles are divided into two classes; that to the motions of the one we are acutely sensible, while to the operations of the other we are totally insensible; and hence to prove that there must be nerves with distinct endowments; *thirdly,* to shew that, owing to the different sensibilities enjoyed by the organ, and the distinct classes of muscles, there is a necessity for the six nerves which go to the eye-ball and eye-lids; and this was the final object of the paper.

No. XVII.—*Case of Partial Paralysis.*

"Mary Unwin, now in the twenty-second year of her age, is about seven months advanced in her second pregnancy: she is of a full habit of body, and instead of having the usual wasting of the face and sharpness of features, she has a plumpness and fulness. She has for some time complained of spasms of the lower extremities. Her constipated state of bowels has required powerful purgatives to relieve her. The head has not been the seat of any particular affection, though, when the inquiry was repeated, she observed that there had for some time existed a dulness over the eyes. She applied for advice respecting a remarkable affection of the face, on the 5th of February. On examining the countenance, a singular distortion of the features is apparent. The mouth is drawn to the right side, and the nose evidently inclines in the same direction. She was asked to put the forehead in action as in frowning, and then was presented the appearance of wrinkles across the right side of the forehead, whilst the opposite side was even and perfectly unmoved. In sleep, the right eye-lids are close as usual, but the left eye remains uncovered. She appears to have no power over the muscles whose office it is to move the eye-lids of the left side.

"There is little (I think no) difference in the sensibility of the two sides of the face. There is occasionally a dimness of vision of the left side, owing probably to the circumstance of the globe of the eye not being lubricated with the tears, as is the case with the opposite one.

"The patient states that she experiences pain on the left side of her neck, and at the root of the ear of that side; but there is no swelling nor marked evidence of inflammation existing in these parts. On pressing on the branch of the *portio dura*, or, as you have termed it, the respiratory nerve of the face, especially in the situation of the parotid gland, no uneasiness is experienced. The iris moves in obedience to the stimuli of light, and the tongue possesses its natural movement. In fact, there is no paralysis in any part of the body, excepting in those parts specified above, and which are supplied with nervous influence by the *portio dura*.

"I have been guided in the treatment of this case by the improvement which your important discoveries have effected in the pathology of partial paralysis. Instead of fearing the supervention of pressure on the brain, I considered the affection as confined entirely to an individual nerve. Formerly, excessive depletion would have been resorted to here: I have adopted moderate evacuation, with local stimuli, &c."

This case was sent, with a very polite note, from Mr Jackson of Sheffield. I wrote to him, and this is his answer:—

"*Sheffield, April* 23. 1825.

"DEAR SIR,—Considerable delay has been occasioned in my replyin to your queries respecting the motions of the eye-ball in the case of partial paralysis of the face, which I had the honour of communicating to you. When the patient attempts to close the eye-lids, the upper lid of the right eye obeys the will, whilst the upper lid of the left side remains motionless; and at the same time the left eye-ball rolls upwards, so as nearly (sometimes entirely) to conceal the cornea.

"During sleep the eyes are similarly circumstanced. The right is closed, and the upper eye-lid on the left side remains as in the state of ordinary vision, whilst the inferior margin only of the cornea is visible; then simulating the appearance, on the paralytic side, of a person in the act of dying.

"During the violent respiratory efforts of labour, the expression and action of the muscles on the left side of the face were lost; in consequence of which, the countenance assumed a singularly ludicrous aspect. I am sorry to add, there appears very little improvement in the state of the patient.

"It affords me great pleasure in having contributed to establish, by a rare and important pathological fact, the truth of some part of your discoveries as connected with the physiology of the nervous system.

"I remain, yours very truly,

"Wm. Jackson."

The manner of this letter must convince my reader how well Mr Jackson is capable of observing minutely. What I drew from the anatomy is here distinctly stated—that, in sleep, the eye-ball is given to that state of perfect rest where the voluntary muscles are relieved from activity, and the involuntary muscles balanced, and that in this condition the eye is withdrawn from the light.

The agony, that is to say, the seeming agony, of dying, is very naturally touched upon. We cannot visit the sick without witnessing the influence of the obliqui on the expression of the eyes. It is the *Strabismus patheticus—orantium* of Boerhaave. Sauvages says, that the eye is turned up towards the close of formidable diseases; "(*Strabismus*) *paulo ante mortem supervenit.*" The vulgar say, that children with water in the head are looking to their final home, "*Vulgo aiunt hos tenellos suam patriam respicere:*" and on this he adds, Wherefore is the superior elevator muscle of the eye convulsed alone, so that the white of the eye only is visible? It passes my understanding: "*ratio me latet.*"

It would indeed be strange if one muscle of a class were thus exerted; but it is not so. The rectus superior is not convulsed; for we have seen, that when that muscle was cut, the eye-ball still turns up on irritation, by the influence of the obliqui; and that the progress of debility over the voluntary muscles of the eye, as over the other muscles of volition, leaves the obliqui with a relatively greater power, and that it is their operation which distorts the eye-balls.

The subject continued.

The three following cases were read from the Case-Book of the Middlesex Hospital, at Mr Bell's lectures, on the 21st and 23d of January, and were made the subjects of clinical remarks. They shew, in a very striking manner, the advantages in the formation of our diagnosis, derived from the discoveries of the distinct functions of the nerves of the head. He interspersed the reading of the cases with remarks, which we put down in the order in which they were made.

These lectures were taken in short-hand, and reported in the Medical Gazette.

No. XVIII.—*Case of Affection of the Nerves of the Head, with Paralysis of the Muscles of the Eye.*

John Windsor, lately a farrier in the 2d regiment of Horse-guards, came to the Middlesex Hospital in the middle of November 1828, and was placed under Mr Bell's care. He has lost the power of elevating the left eye-lid, so that it covers the eye, as in the case of ptosis: but his chief suffering arises from a continual and severe pain seated in the left side of his face.

He gives the following history of his illness. He was wounded in the commencement of the battle of Waterloo, by the bursting of a shell which he saw coming towards him. He was struck on the left temple and cheek-bone, and was rendered insensible. He recovered his senses on the second day, and then found himself in the hospital at Brussels. He was soon restored to health; but it was some time before he recovered from an inflammation of the left eye, which had been injured by the mud thrown into it at the time he was wounded. Five years after receiving this wound, he got a second hurt in the same place, while shoeing a horse: the animal kicked out, and threw him against a wall; his scalp was turned up, and bled profusely. He continued in the regiment, fit for duty, until about a year and a half ago. Previously to this time he had become subject to severe headaches and giddiness. He then had an attack of hemiplegia on the left side. From this he soon recovered; but there was no abatement of the severe pain in the head to which h was subject. "It all rested itself," he said, "in the forehead, and in th left cheek." Four months ago, when the pain was dreadfully severe, s as almost to make him frantic, he suddenly lost the power of opening hi left eye; the eye-lid dropped and hung like a curtain over it, thus depriving him of vision in this eye.

Clinical Remarks.—"You will recollect, gentlemen, how the eye-li is moved, and by what nerves. The attollens palpebræ superioris arise along with the recti muscles, and running over the eye-ball and upon th superior rectus, has its tendon spread into the ciliary cartilage. Thi muscle is supplied by a branch of the third nerve. The orbicularis pal pebrarum shuts the eye-lids, and is supplied by a branch of the portio dura of the seventh pair, coming round superficially from before the ear. This falling of the eye-lid, therefore, implies that a disease has affected the third nerve in its course: the power of winking and corrugating the eye-lids remaining, implies that the seventh nerve, by its circuitous course, has escaped that diseased influence."

At the same time it was discovered by the surgeon who attended him that he squinted; when his left eye was exposed it was seen fixed, and looking outwards. It remained in this position for ten or twelve days; but afterwards it came gradually to be directed forwards.

"This circumstance would simply shew, that whilst the principal muscles of the eye were paralysed by the pressure on the third nerve, the abducens, or sixth nerve, had for a time escaped; but that the disease at length encroached upon the sixth, and consequently paralysed the rectus externus, and thus reduced all the muscles of the eye to the same condition."

The upper lid of the left eye completely covers the eye-ball. When asked to try to raise it, he arches the eye-brow, but produces no effect on the eye-lid. He can wink, and shut this eye forcibly. When the eye-lid was raised with the finger, and he was asked to look around in various directions, it was found that he had no power of moving this eye either sideways, or upwards, or downwards; but, whilst the right eye was revolving from one side to the other, this remained perfectly stationary. When the eye-lids were again held apart, and he was told to wink, still the eye-ball continued fixed.

"You know the eye-ball is turned up by two different muscles. If you direct your eye upwards to look at an object, the rectus superior and attollens palpebræ combine together, and both the eye-ball and eye-lid are raised. If there were not such a combination between these two muscles, the eye-ball might be turned up by the effort of the rectus, but instead of seeing by this means, the pupil would be turned under the eye-lid. Again, when the eye-lids are opened by the fingers, and held apart, and the person is asked to shut them, you see the eye-ball roll up. Here the rolling up of the eye-ball, combined with the action of shutting the eye-lids, is not performed by the same muscle which turns the eye-ball up in vision. This motion is involuntary, and is performed by the inferior oblique muscle. But this, as well as all the other motions of the eye, are in this case gone, which shews that all the nerves of the muscles within the orbit are affected."

Although he has lost the motions of his eye, still he retains vision in it. This is slightly obscured by a nebula upon one side of the cornea; which has been the same ever since he had inflammation of the eye consequent on the wound received at Waterloo. The pupil of the left is dilated considerably more than that of the right eye, without any irregularity of its shape. Upon a careful examination, not the slightest motion of the iris could be perceived in the left eye. He can distinguish light from darkness through the eye-lid. He complained of the candle-light giving him uneasiness.

"When you simply close the eyes, but are awake to all that is going on about you, you see the light through the eye-lid: the eye-ball does not turn up. But when the eye is closed in sleep, the eye-ball does turn up, the pupil is directed upwards, and the light, coming through the eye-lid, is less of an annoyance. In this case, as in others which I have seen, the axis of the eye remaining in its usual place, although the eye-lid be dropped, the patient complains of the light of the candle in the ward.

"You will further observe, in what has been read, that the iris is insensible to the variations of light. This reminds you, that the relation established between the retina and iris is not direct,—is not in the organ; but the impression must be carried back to the sensorium through the optic nerve, and return again through the third nerve. Therefore, by the influence of the third nerve being destroyed, we see why the motion of the iris should be arrested."

The surface of the eye is quite insensible to touch. When we held up the eye-lid, and threatened to touch the eye, he drew back and winked before the finger had touched him; but when the finger was drawn across the eye-ball, he did not feel it. This eye is equally bedewed with moisture as the other. There was not observed to be any increased flow of tears after touching it. This eye is a little more prominent than the right one.

"You will observe these circumstances with interest. When he saw you aiming, as it were, to injure the eye, he winked, because the vision was perfect, and the motion of the orbicularis palpebrarum remained: the circle between the retina, brain, and the muscle, being entire. But this was not the case when you touched the eye. On touching the eye, the impression should be upon the fifth nerve; but the fifth having lost its function, there was no impression carried backwards to the brain, and of course none was given to the portio dura of the seventh, to bring the orbicularis into action."

His reason for applying for relief is not so much on account of this condition of the eye, as that he suffers such excruciating pain in the left side of his face. His appearance shews how harassed he is with long continued suffering. The pain extends over all the left half of his face, and he points to the forehead, the cheek, above the angle of the mouth, the chin, and the side of the tongue and the gums, as the parts principally affected. It is a dull aching pain; but in the side of the tongue it is rather of a burning kind. All these parts are much deadened in their sensibility, but more so in some parts than in others. Thus sensation seems altogether gone upon the side of the forehead, and we may rub the surface of the eye with the finger without his feeling it; while, in the other parts of the face, he can merely, in an imperfect way, distinguish whether we touch him or no. On tickling the orifice of the left nostril with a feather, he made no signs of this annoying him; but he started back and pushed the feather away whenever it was put to the right one.

"I must remind you, that upon an injury to a nerve any where in its course, the pain is referred to the extremity of that nerve. If we could imagine, as is most probable in the present case, that a tumour or abscess engages the root of the nerve, then there would be pain, not in that part, but referred to the extremities of the nerve. This, perhaps, accounts for the pain in the corresponding side of the face and of the tongue. And you will observe at the same time, that it is quite consistent with this opinion, that the parts which are the seat of this morbid pain should still be insensible when touched: for the disturbance in the root of the nerve which causes the false impression of pain in the extremities of it, prevents the sensation being conveyed from the surface towards the sensorium."

As it appeared that there was here an affection of the trigeminus, or fifth pair of nerves on the left side, we were led to examine the condition of the temporal and masseter muscles. He was directed to open and shut his mouth, and clinch his teeth firmly together; and while he did this, the fingers being placed first upon the two temporal muscles, and then upon the two masseter muscles, the comparative degree of action in them was observed. It was distinctly perceived by all who examined them, that while the muscles on the right side bulged out and contracted naturally, those upon the left side were quiescent. The masseter on the left side was wasted and flaccid, so that the surface of the jaw-bone could be easily felt. The corresponding muscle on the right side was hard and full.

"You will remember, in the demonstration of the fifth pair of nerves, that it bore an accurate resemblance to the spinal nerves; that the anterior root passed the ganglion on the posterior root, and went to the muscles of the jaws; so that this nerve, like the spinal nerves, possesses a double function. If, therefore, a disease affects the roots of this nerve, we should expect, what is here stated, that at the same time that the sensibility of the face was diminished, the muscles of the jaws should be weakened."

The temperature of the skin on both sides of the face appeared to the touch quite the same. He was ordered to have six leeches applied every third day behind the left ear; to take a Plummer's pill every night; his bowels to be kept open with salts and senna; to rub the back of his neck with the camphorated mercurial liniment, and the lotion of lead and opium to be applied to the left side of his face.

Dec. 24th.—He has attended as an out-patient, and has expressed himself somewhat relieved by the treatment. But to-day he complains of being much worse: the pain in the side of his face is more severe; he has almost entirely lost vision in the left eye, and yet the eye is quite transparent: this has come on gradually since yesterday, and has not been attended with flashings of light. He is also deaf in the left ear, but this symptom has been coming on during the last week.

Dec. 29th.—This man was admitted into the hospital on the 24th, but he left it late on the same night, and returned home. Being visited at his house, he said that the patients in the ward had complained of the noises he made while trying to blow his nose, and therefore he left the hospital. He has formerly complained of an obstruction to his breathing at the back part of his nostrils. He sometimes starts up in bed with a sensation as if he were choking, and makes strong efforts, by sneezing, hacking, and blowing his nose, to remove something which seems to block up the posterior nares: he also made use of a bit of wood, which he thrust into his back nostrils on the left side, and picked away pieces of a substance resembling glue, tinged with blood.

" I presume nothing can more convince you of the insensibility of the surfaces resulting from the disorder of the fifth nerve than this practice of the poor man. He is tickled with a feather on the right nostril, and yet on the left he thrusts back a rough stick into the cavities of his nose."

This difficulty of breathing was much aggravated on the day he was admitted into the hospital.

On the night of the 26th he was extremely ill; suffering very great pain in the forehead, having a succession of cold fits, and no sleep. In the morning his wife was alarmed by finding his face twisted to the right side; and she immediately went to obtain medical assistance at a neighbouring dispensary. He was cupped at the back of his head, and afterwards a large blister was applied.

The muscles on the left side of his face are paralysed. The eye-lid can now neither be elevated nor shut: it remains in whatever position it is put by the finger, being like that of a dead person. There is great redness and turgescence of the conjunctiva, and there is a film, as if it were dried mucus, covering the greater part of the surface of the eye. The patient said he had picked some of this off with his nail. He was cautioned against repeating this, and his wife was instructed to bathe the eye frequently, and to cover it with its eye-lid. When the face became paralysed the pain was considerably abated, and now he suffers comparatively little from it; the sensibility to touch is still defective as before.

" In these circumstances we have a proof of two properties of the nerves being necessary to the preservation of the eye. The sensibility to impression is followed by the winking or closing motion of the eye-lids, which washes off, or otherwise removes, the offending body. There was danger to the organ when its guardian, the sensibility, was destroyed; but when, at length, the winking motions were lost, and the tension of the orbicularis muscle, which supports the eye, gone, then a destructive inflammation very quickly followed. And you have here in this case, as you may have also seen lately in a patient in the cancer ward, the very singular phenomenon of a person picking the inflammatory crust from the surface of the eye.

"I may here make a clumsy comparison to illustrate this subject, and yet I believe the analogy is perfectly correct: Formerly, in speaking to you of the fractured spine, with the loss of sensibility in the hips and the lower extremities, I told you that it was necessary to direct the nurse to shift the patient a little, from time to time, and to support him with pillows, put under the loins, hips, and thighs, otherwise your patient would soon have mortification of the hips. Consider how often you have shifted your seats since you have taken your places before me this evening,—that irksomeness, which makes you change the pressure from one hip to the other, is the guard upon the texture of the part; and if you had not that uneasiness, you would have worse when you rose up—you would have actual pain, followed by inflammation. But if a person who has the spinal marrow torn across have no such shifting motions, no little accommodation of posture so as to throw the pressure upon different parts, then you know the consequence is, that, being neglected, he has mortification of the hips or heels. Thus, we understand the necessity of pain or uneasiness as a continual monitor to us; and we see in the eye what is the effect of the loss of this sensibility, that it inflames, loses its transparency, and is finally destroyed."

He can twist his tongue about: he has no numbness nor loss of motion in his extremities, and his intellect is perfectly clear.

Dec. 31st.—His hearing has now returned to the left ear: the pain in his face is less.

Jan. 14, 1829.—He returned to the hospital to-day. He has now regained the power of motion in the muscles of his face to a certain degree, but not perfectly: his eye may now be said to be completely lost: the conjunctiva is of a bright red colour, and the cornea projects like a horn, being apparently about to slough. The pain which was so severe in the forehead is now entirely gone. He complains more of pain in the back of his head. A seton has been put in the back of his neck.

Jan 29th.—The cornea has sloughed, and a part of the humours, of a dark pulpy appearance, projects from the centre of the eye: when he presses the eye, it bleeds. He is much better in other respects.

May.—This man progressively improved, and he attributed his relief to the seton placed in the back of his neck. His eye-ball was found one morning to be turned inwards, and it remained permanently so. It became clearer, but he never recovered vision in it. By degrees the sensation returned to the skin, and the pain in his face entirely ceased. The action of the muscles of the jaws could again be felt when he chewed.

(The continuation of this case was given in a clinical lecture delivered some time afterwards to the pupils of the Hospital.)

"I shall now present an instance of disease of the fifth pair of nerves, which will give you a correct notion of this subject. It is a case in which we had on a former occasion to reason upon the symptoms only; but now, instead of looking to the probable causes of the symptoms, we have the dissection before us, and may therefore follow our course of reasoning more securely in an opposite direction. It is the case of a man named Windsor, who was a patient in this hospital. He was wounded on the head by a bomb-shell at Waterloo; that is the first part of his history: he recovered from this, but, while dressing his horse, received a kick on the same side of the head, and after this there was severe pain in the left side of the forehead and cheek. The next symptom was a loss of power of opening the left eye, and then the eye-ball became fixed, looking outwards, and he consequently squinted. This was very different from the condition of the woman who received a blow on the head and a fracture of the skull, and whose case I remarked upon when lecturing on injuries of the head. She looked inwards, and moved her eye and eye-lids; but Windsor's eye looked outwards, and was permanently fixed. The next thing that we find is, that by degrees the eye changed its position, and was presented directly in the centre; but the eye-ball was still motionless. The muscles of the face retained their power; he could frown, and knit his brow, and he could wink. If he held his eye-lids open, and you waved your hand before him, he winked with the eye-lids, but not with the eye-ball; that is to say, there was no motion of the eye-ball during the effort of winking. If you make the same trial upon the eye of one of your friends, holding the eye-lids apart with the fingers, and then threatening the eye with the other hand, you prevent the eye-lids from closing; but you will see, at the time that the motion of shutting the eye would take place if your fingers did not keep the eye-lid raised, that the eye-ball turns up. No such effect, however, took place in this patient; which shews, that not only the voluntary motions of the eye-ball were gone, but that the involuntary rolling of the eye, which accompanies winking, was also lost. He complained of the uneasiness which the red light of the candle, seen through the eye-lid, gave him as he sat at home at night. The surface of the eye was insensible to touch, so that drawing the finger along the eye gave him no pain; and it was only when he *saw* the finger approaching the eye that he winked. The whole of the left side of the face, which is supplied by the branches of the fifth pair of nerves, was deprived of sensation; and when he closed his jaws, the masseter and temporal muscles no longer bulged out or became rigid, like those of the right side, but were wasted and flaccid. He retained his vision, which was remarkable, when the sensibility of the surface, and all the motions of the eye were gone. Vision remained, but the pupil was dilated, and did not move with the variations of the exposure of the eye to light.

"He continued in this condition during many months; and, notwithstanding the loss of sensation and motion in his eye, that organ preserved its natural transparency.

"Afterwards, he was seized with paralysis of the muscles of the left side of his face. The eye-lid being now deprived of the power, both of being elevated and of being closed, remained in whatever position it was accidentally placed. Violent inflammation of the conjunctiva now came on, and a thick deposit of granulations covered the whole surface, obscuring, or rather totally destroying, his vision in this eye. After the lapse of some months, he recovered the power over the muscles of the face; but until his death, the pain and insensibility of the side of the face, and the loss of motion in the eye-ball, remained the same as when he first presented himself. I shall now read the account of the dissection, made by Mr Alexander Shaw, who attended the patient at his house, after he had ceased to be a patient of the hospital, and who drew up the case."

May 1830. Dissection.—Having turned down the scalp and prepared to saw through the skull, a remarkable contrast was observed in the appearance of the two temporal muscles. The temporal muscle of the left side was pale, thin, tendinous, and deficient in its due proportion of muscular fibres; whilst that of the right side had the usual red fleshy colour, and was twice as thick as the former. On comparing the two masseter muscles, the same contrast was presented: the right had the natural size, colour, and texture, while the left was blanched in appearance, thin, and wasted. A considerable quantity of serum escaped from beneath the dura-mater; the superficial veins were turgid with blood; the ventricles were unusually large and full of serum, and the substance of the brain appeared of a darker colour than is quite common. Upon turning out the base of the brain from the skull, the first thing that attracted notice was, that the left optic nerve had a dull and ash-grey colour, whilst the right was of the natural pearly-white colour. When raising the brain from the left side of the sella turcica, adhesions, apparently of some duration, were found between the brain and dura-mater; there was also increased redness of this part. Upon separating the adhesions, a tumor was exposed on the side of the sella turcica, and with the dura-mater stretched over its surface; its highest part was on a level with the sella turcica—it reached forwards to the foramen lacerum, which it entirely closed—it extended laterally as far as to the foramen of the meningeal artery, and posteriorly as far as the posterior clinoid processes. Thus the tumor occupied the whole of the cavernous sinus. Its texture was like that of cheese, but rendered tougher by an intermixture of fibrous structure. The pituitary gland was converted into the same kind of texture as the tumor, and appeared as if it formed a part of it, but its shape was not altered: it was so hard that it could be cut in fine slices. The whole tumor was easily detached from the bone by using the handle of the knife, and the bone exhibited no appearance of disease. On examining the posterior nostrils with a probe, it did not appear that any part of the tumor was lodged there. The nerves which passed through the cavernous sinus—the third, the fourth, the fifth, and the sixth pairs—were imbedded in the substance of the tumor; the optic nerve passed over it. All these nerves, between their origin from the brain and the tumor, were of a dull grey colour, were diminished perceptibly in size, and formed a contrast with the nerves of the right side. The nerves of the left side which were not imbedded in the tumor—that is, the seventh, eighth, and ninth pairs—possessed their natural and healthy appearance.

" In the first place, you observe from this dissection, that, as the tumor embraced the fifth nerve, it proves that the want of sensibility in the surface of the eye and surface of the face, and internal cavities of the nose, inside of the mouth, and side of the tongue, was owing to the interruption of the functions of this nerve by the pressure of the tumor on its trunk. The pain in the side of the forehead (a part which was insensible) is to be accounted for by the inflammation and the disease making progress in the nerve itself. The worst case of this kind that I ever met with, was where a small tumour invested the popliteal nerve: the man actually died of pain—pain in the sole of the foot. Here, in Windsor's case, from the disease engaging the nerve on which the sensibility of all the surfaces of the head depends, the sensation of pain was referred to those parts to which the extreme branches of the nerve are distributed, although these were perfectly insensible. Then you find that the tumour made its progress to the nerves which enter into the orbit by the foramen lacerum. It first involved the third pair of nerves; because, you recollect (and it is very remarkable), that the eye-lid dropped, and the eye-ball could not be moved, and the pupil was directed outwards. How was that? Why, the anatomy would tell you. This tumour gradually increasing, first involved the third pair, the motor oculi, and left the sixth pair out of its grasp for a time; so that the sixth pair, and consequently the abducens muscle, retained their power, while that of the other muscles was lost. Thus it was, that instead of the eye moving in all directions, it was moved only in one; and, there being no opponent to the action of the abducens, the eye remained looking outwards. But at length the tumour amalgamating with, and extending itself to, the neighbouring parts, encroached on the sixth nerve also, and produced on it the same effect which it previously did on the third pair: the abducens muscle was then rendered as feeble as the rest, and all the muscles being paralysed, and no one having the preference, as it were, the eye was brought to the centre of the orbit, looking straight forward, but fixed.

" It is stated that the power of shutting the eye remained. Certainly: Because it has been discovered that the fifth has no direct influence over the muscles of the eye-lid; the branch of this nerve on the forehead is a nerve of sensation, and not of motion. A circumstance occurring to me in practice well illustrates this. I cut across the branch of the fifth upon the forehead of a nobleman. It had no effect at all upon the motions of the forehead. In the consultation which followed, it was said, 'He has not cut across the nerve; there is motion of the forehead—motion of the eye-brow.' See, then, how important it is to ascertain which nerve gives motion and which gives sensibility. What was it which encouraged so many friends of my standing to cut across the branches of the fifth nerve for tic doulоureux? Because it was attended with no distortion of the countenance. It is said that the best experiments are those which are made without any idea at all as to their results; with no preconceived notion —with no bias; that it is then only that an experiment is fairly made. Now I doubt whether any philosopher, or any one pretending to be a philosopher, ever made an experiment without some intention, some object in his mind. But here you have the very curious phenomenon—experiment, if I may call it so—of the branches of the fifth pair cut in every different part of the face, without any expectation of the effect produced. Here is the very consummation of that unbiassed condition of the mind so much desired. What followed these frequent operations? In one patient the nerves were cut, I dare say, a dozen times, by the late Mr Crúickshanks: 'nine incisions, together with some smaller ones,' (all on one side of the face), is the expression in the account of the case—but without any observation at all—without any consequences, resulting from the series of experiments thus made upon the man, being noticed: 'the patient set out for Liecestershire, perfectly restored.' Now this silence must have been because, in cutting across the fifth pair, surgeons found no distortion in the face; whereas, if the fifth pair had been the source of motion, the first patient that they cut would have been the last; the distortion would have been so unpleasant, so extraordinary, and so disgusting—you may see in the hospital what a horrid appearance it gives when the portio dura of the seventh is destroyed —that nobody would have suffered the nerve to be cut. When I cut across the supra-orbital nerve, and saw no effect produced, I reflected—was it possible that I could have missed the notch in the frontal bone? I then thought of a near relation of mine who had an abscess here, on the temple, and who had a very animated countenance; but in whom, in consequence of suppuration taking place, all the animation was confined to one side of the forehead, while the eye-brow of the other side remained motionless. It was thus impossible to avoid the conclusion, that one nerve caused the motion of the features, and that it was another which gave rise to the sensibility of the surfaces of the face. Hence you see that the power of shutting the eye remained, in the case which we are speaking of, because the portio dura, proceeding by a circuitous route to the eye-lids, was free from the disease: this nerve coming through the temporal bone, and spreading its branches to the orbicularis oculi, bestowed the power of motion on that muscle; so that, while the action of all the muscles of the eye-ball was gone, and that of the attollens palpebræ along with them, the eye-lid could be closed upon the eye; and to enable the patient to see objects, he was obliged to open the eye-lids with his fingers.

" The temporary paralysis of the face, which you find stated in the case, is so far remarkable, that it proves that the inflammation of the tumor at one time increased, extended to the root of the portio dura, and subsided. It was from this occasional increase of the inflammation, indicated also by the adhesions, that the root of the seventh pair became involved, and paralysis of the muscles of the face was produced.

" Now there is one point connected with the eye very worthy of your attention in this case—the destruction of the outward organ, when paralysis of the face, and consequently of the orbicularis oculi, took place. Once more I must express my surprise that the well educated members of our profession should have such a desire to countenance M. Magendie in his views regarding the influence of the fifth nerve upon the organs of sense. One would naturally imagine that it was the simplest thing possible to comprehend the peculiarity of the sensibility of the nerve of sense, the retina, as distinguished from the perfection of the organization which ministers to it, and is accessary to it. In this dissection, you see that the optic nerve escaped contamination, as it were; it was only forced aside—not involved in the actual disease; and therefore you learn with interest, that whilst the outward apparatus was becoming more and more injured, the sensibility of the surface lost, and the motion gone, the patient was sensible to light. But this sensibility of the retina could not, it is obvious, give vision, whilst the exterior apparatus was imperfect. Further, you perceive the necessity of the sensibility of the surfaces of the eye, and of the motions of the eye-lids and of the eye-ball, connected with that sensibility; that the transparency of the eye, and the exercise of the retina, may be preserved. When the fifth, and the third, and the sixth and the seventh nerves, in succession lost their powers, although the source of the tears remained, there was no governing sensibility, and no motion to wash the eye; motes fell upon its surface, irritated it, inflamed it, and then came opacity, and loss of vision.

" There is another interesting circumstance in this case, which you will have patience to attend to. Before the portio dura became affected, and while the eye was transparent, if the candle was brought near the patient, he suffered unusual irritation in the eye; and sitting with his friends, he had to shade the eye from the light with his hand, although the eye-lids were closed. This is a thing which might escape your notice altogether. Why was it that he suffered irritation in an eye which seemed to be so securely guarded, that the eye-lid was never open? It was because the eye-ball never rolled upwards: the pupil was stationary; it was covered only by the thin membrane of the eye-lid, and that, as your own experience will prove to you, permits a red lurid light to pass through; and red light is, you know, the most irritating of all to the eye. The loss of power of the muscles not only embraced the voluntary motions, but the involuntary guarding motions of the eye; and the most important of these is the revolving of the pupil upwards during the perfect repose of the eye; by which means it escapes being exposed to those rays that penetrate the eye-lid.

"Aiming at him with the hand, he winked, because he saw the effort to strike him; and he winked through the action of the portio dura, the office of which was perfect; though at the same time you could draw your finger across his eye, and under the eye-lid, without his winking, or any motion being produced. This brings to my recollection the case so happily commented on by Dr Watson. There also it was remarkable that you might draw your finger across the eye, and the patient knew not that you did it, unless when it came opposite the pupil, and obstructed the vision.

"You must have observed, in reading your collections of cases, that where there is one well described and authenticated case, you may find others following it. The things of which we are now speaking are of daily occurrence; and the only singular circumstance is, that hitherto they have not been noticed."

No. XIX.

"I have now the pleasure of directing your attention to a case furnished, by a gentleman who deserves well of his profession, Mr Bishop, in a paper entitled "Observations on the Physiology of the Nerves of Sensation, illustrated by a case of Paralysis of the Fifth Pair," communicated to the Royal Society. I likewise attended this lady, in whom I found all the symptoms that I have described to you; the excruciating pain in the upper jaw and face—a pain quite unlike tic douloureux—a continued gnawing pain—whilst there was complete insensibility to impression. The account states that the globe of the left eye was quite insensible to touch, though she retained the power of vision unimpaired. The left nostril received no impressions from the most irritating stimulants, such as snuff or ammonia, yet the sense of smelling continued. The left side of the tongue was insensible to impressions both of touch and of taste. On examining the brain after death, a scirrhous tumour was found lying on the inner surface of the sphenoid bone, extending laterally to the foramen auditorium internum, and resting posteriorly on the pons varolii, which was slightly ulcerated. The tumor had completely obliterated the foramina for the exit of the three branches of the fifth pair of nerves. Here, then, there was a disease of the trunk of the nerve, an exact counterpart to the case of Windsor, confirming it in all its details; and therefore I need not say another word upon it. As Windsor's case occurred in the hospital, it more properly belongs to you and to this occasion.

"I have gone so fully and repeatedly into the comparison of the anatomy with the symptoms in these cases, that I shall not make any comment on the note of the case which follows, but recommend it to your attention."

No. XX.—*Disease of the Fifth Pair, and of the Nerves within the Orbit; with Paralysis of the Arm and Leg of opposite sides.*

James Godwyn, æt. 29, formerly a servant, gives the following history of his complaint. Eighteen months ago he was attacked with a severe pain, which extended over the left side of his face, temple, and crown of his head; and shortly afterwards he lost the sensation in these parts, and in the surface of the eye, and in the inside of his mouth and nostrils. He experienced at the same time a weakness in closing his jaws, when he attempted to chew upon the left side. The eye-lid of this side dropped, and he was unable to elevate it; and his eye was motionless; so that, to use his expression, 'it was *set* in the socket.' His vision remained in both eyes; but he saw objects distorted and double. The left half of his tongue was insensible, so that the morsel frequently lodged between it and the gums without his consciousness; but still he could move his tongue about in every direction. He was not deaf in either of his ears; but he was distressed by a painful ringing in his ears, and he had frequent giddiness. Soon after the commencement of these symptoms his right arm became weak, and affected with numbness; and then his left leg was attacked in a similar manner.

"He is now much better, and only comes occasionally to the hospital to visit his physician Dr Watson. The pain in his face, or gums, where it was principally severe, is greatly diminished. Although the sensibility is not perfectly restored, it is very nearly so. When he is made to clench his teeth, the muscles of the jaw on both sides appear to act with equal force. He can now elevate the left eye-lid, and roll the eye-ball; but there is a want of correspondence between the motions of the two eyes, which sometimes gives him the appearance of squinting. Occasionally the left eye-lid is only partially raised, while the right is elevated to its natural degree. Sometimes, again, when he winks or depresses the eye, as in looking downwards, the right eye-lid alone drops, and the left remains open nearly to its full extent. The pupil of the left eye is more dilated than that of the right, and it does not contract by a strong light. He has still a debility in his right arm and left leg, which makes him halt and hang his arm like a paralytic.

"And now I hope that I have gone far enough to point out to you the necessity of observing that there are different qualities, or endowments, in different nerves, and that, when you take this principle along with you, and attend to the anatomy, you have only an agreeable exercise of your attention to reconcile the symptoms; which, without the just knowledge of the functions of the nerves and muscles on which they depend, are puzzling in the last degree.

No. XXI.—*Notes of the Case of a Patient who had Paralysis of the Muscles within the Orbit.*

Geo. Bungay, æt. 20, was admitted, under Dr Macmichael's care, Nov. 22d. He had symptoms of fever for a week before he presented himself at the hospital. He complained of getting no rest at night: his bowels were constipated; his tongue foul; the pulse slow and regular; he had slight tenderness in the epigastrium; he suffered no pain in the head. On the night of the 23d the nurse said he wandered a little in the night. On the following night he had no rest. In the afternoon of the 25th he was seized with delirium; the delirium came on in paroxysms. After this he fell into a comatose state. He continued in this state until his death, which happened on the 29th.

When the delirium came on, it was observed that the right eye remained always closed, while the left eye was opened: he had lost the power of raising the lid of the right eye. Upon elevating it with the finger, it was discovered that he had lost all motion of the eye-ball: while the left eye revolved from one side to the other, this remained still, and as if he were looking straight forwards. On holding the eye-lids apart, he resisted with the orbicular muscle, and closed them again forcibly together.

Dissection.—There was a considerable quantity of serum in the ventricles of the brain. On raising the brain from the basis of the skull, both the optic nerves, but in particular, the right one, were observed to be more vascular than natural. On dividing these across, and continuing to turn back the brain, it did not separate easily as usual. There was found to be a thick deposit of coagulable lymph, straw-coloured, and of the consistence of jelly, which caused the upper part of the pons varolii to adhere to the dura mater. This was most abundant on the right side of the sella turcica. All those nerves which passed into the orbit were enveloped in this deposit: the third pair of nerves was completely embedded in it, and had a yellowish-brown appearance. The corresponding nerves upon the left side were also affected, but in a slight degree. On examining the roots of the portio dura of the seventh pair, they were found quite removed from the disease.

" You will in this case distinguish the symptoms of delirium and coma from the local affection; and as regards the appearances on dissection, you will also distinguish the result of the general condition of the brain from the more local effects upon the base. The effusion into the ventricles of the brain shews the state of general excitement; but it is to the coagulable lymph matting the third, fourth, fifth, and sixth nerves together, that you must look for an explanation of the symptoms in regard to the condition of the eye. The root of the seventh pair being free from the disease, explains how the eye-lids retained their winking motions, whilst the eye-ball was stationary from the disorder affecting the third, fourth, and sixth nerves.

"If I brought to you my private cases of consultation, you might suppose that, owing to circumstances, cases of diseased nerves were accumulated; but you now perceive, in the common practice of an hospital, how frequent these cases of nervous affection are; and the interest you attach to them, proves to me the advantage of an accurate knowledge of the anatomy in exciting minute attention to symptoms, and satisfactorily explaining them. If you had not known the distinct uses of the fifth and seventh pair of nerves, you would have had no gratification in following these details."

No. XXII.—*Case of Partial Paralysis of the Face.*

James Delahay, æt. 13, Nov. 26.—Seventeen days ago he fell from a scaffolding ten feet in height, and was brought to the hospital immediately after the accident, suffering from the effects of concussion. There was general tumefaction of the left side of his head, from the jugum to the vertex, and there was a bruise of the scalp above the ear, marking the place on which he had fallen. He recovered his senses about an hour after the accident. His head was shaved, leeches and cold lotions were applied to it, and he took purgative medicines. At the end of a week he was so far recovered as to be dismissed from the hospital. He continued in good health until Sunday last, when he had a severe headach, which went off in the course of the day. On Monday his friends were alarmed by observing his face twisted to one side; they therefore sent him to the hospital, and he became a patient of Mr Bell.

The left side of his face is relaxed, and the natural balance of the features is gone, so that the countenance has a distorted, wry appearance.

"You have so lately had a demonstration of the nerves of the head, that I need hardly remind you that all the motions of the face,—the motions of the forehead, of the eye-lids, the nostrils, the expression of the cheek and lips, both in passion and in speech, result from the influence of the portio dura of the seventh pair; and that the muscular branches of the fifth pair are given to parts internal, and to such as have no direct connexion with the actions of respiration. The debility or disorder of the portio dura has the most unhappy consequences upon the countenance. When the nerve has lost its power, the corresponding side of the face becomes immoveable as a mask, or it is drawn to the opposite side by the excited action of the muscles there. It is important in your practice to observe the different causes of this defect: the slightest, perhaps, is an influence on the surface; the next is a swelling of a gland, in the course of the nerve, which presses upon it; the third is a suppuration within the ear; the fourth is a suppuration at the basis of the brain; and, lastly, the defect may arise from none of all these, but from the condition of the brain itself, and may be in correspondence with the paralysis of the other motor nerves. In the present case, the boy received a violent injury on the same side of the head on which the paralysis is; and we have had cases in the hospital where the portio dura was torn by the fracture passing through the temporal bone;* but in the present instance this could hardly be the case—the paralysis would have taken place at once, whereas it has come on at a later period, and has been accompanied with swellings of the glands of the neck, and with no defect of hearing on that side."

The left eye stares widely and unnaturally open, while the right is only moderately disclosed; when he makes an attempt to close the eye-lids, the left remains unmoved; but the eye-ball is elevated upwards; and it is raised to so great an extent, that the pupil is quite concealed beneath the upper lid, the white of the eye only being exposed. He is unconscious of the eye-ball thus revolving upwards: the objects around him in the ward are not seen at all while it takes place. He was told to direct his eye so as to look as straight above him at the ceiling as he could: when he did this, it was observed that he could not raise the pupil, by his utmost efforts, so high, by some degrees, as during the involuntary act. When turned up in the effort to wink, the cornea rose so as to be presented towards the roof of the bony orbit, and consequently quite concealed by the eye-lid; on the other hand, when he looked upwards at the ceiling, more than one-half of the pupil remained visible. During sleep the eye-lids are wide open; and the pupil is concealed, just as it is observed to be when he winks. It is remarked that the globe of the eye protrudes considerably more than the other; the conjunctiva is inflamed, and is loaded with numerous bloodvessels. He says that he suffers pain from this eye being constantly open, especially when he is sitting before the fire at night.

"I am sure you have listened with interest to the statement of these facts, which you can yourselves verify; and, first, as to the protrusion of the eye. Any one ignorant of the functions of the nerves, looking upon this boy, and observing the defect of the eye-lids, and the protrusion of the eye, would say that there must be some tumour in the orbit forcing out the eye; and this they would, no doubt, also consider was the cause of the debility in the muscle. But by a more correct process of reasoning you perceive that the defect is solely in the portio dura of the seventh pair. The eye-ball is naturally held between the muscles within the orbit, and the orbicularis muscle without; but in this case the exterior muscle, viz. the orbicularis palpebrarum, has not only lost its activity, but its tone; and the greatest difference may be perceived between the right and left eye-lids by pinching them up with the finger and thumb. There is thus a want of pressure exteriorly, which permits the muscles within the orbit to press the eye-ball out, and is the reason of the prominence of the eye. Indeed, this want of support may, in part, conduce to the inflammation and debility of the eye, which result in those cases where there is a defect of muscular action.

---

* See the next case.

"I shall direct your attention to one more circumstance only in the narrative; viz. the difference of the extent of motion when the pupil is directed upwards by volition, and when it is turned up by the instinctive and involuntary actions of the muscles. I think I formerly told you that on cutting the superior rectus in the monkey, the animal lost the power of directing that eye upwards; but when the eye was stimulated by the end of a feather, and the effort to wink or close the eye was produced, the eye-ball turned up, and the pupil was concealed under the eye-lid. Such an experiment, I think, satisfactorily proves that the superior rectus is the voluntary muscle, and the inferior oblique the involuntary muscle to turn up the eye-ball. To suppose that the eye is revolved upwards by the superior rectus when the eye-lids are closed, would be to make this muscle act at the same time with the contraction of the attollens palpebræ superioris, and act also at the moment of its relaxation. Thus, when you look upwards to the ceiling, you elevate the eye-lid at the same time that you raise the eye; you perform the motion of the eye-ball with the superior rectus, in conjunction with the attollens palpebræ superioris. If there were not this sympathy between these two muscles, the eye-lid would not be raised in proportion as the eye-ball was turned up, and no advantage would be derived from the revolving of the eye-ball, since the pupil would be turned under the eye-lid. You see, then, there must be a strict sympathy in the contraction of these two muscles. But we have another action in the eye-ball to provide for—a rolling upwards of the eye-ball while the eye-lids are closed, as in winking and in sleep. Now, to suppose that the eye-ball was in this instance also rolled upwards by the rectus, would be to make it act both with the contraction and with the relaxation of the attollens palpebræ. Thus by reasoning, as by experiment, we come to the conclusion that the instinctive rolling up of the eye-ball, as in winking, is not produced by the action of the superior rectus, but by the inferior oblique muscle.

"In this youth the motions of the eye-ball, in its different conditions, can be well observed, owing to the eye-lids remaining open: for example, we ascertain that the eye-ball turns up when the effort is made to close the eye-lids. With regard to this motion, it is curious to observe that here, as in many other instances, part only of the action is voluntary and sensible—viz. the closing of the eye-lids; whilst the other part, the revolving of the eye-ball, is insensible. We have an opportunity of further observing, as the narrative proceeds, that in the voluntary direction f the eye upwards, the action is limited; indeed we may say, what ould be the use of that muscle (which is to direct the axis of the eye vision) carrying the centre of the cornea higher than the margin of the bit, and under the upper eye-lid? But we do see a reason why the bliquus, in the involuntary motion of the eye, should carry the cornea uch higher up, since the object is to moisten it at the fountain of the ars, and to purify it from all irritating matter. Accordingly, when this outh's eye is irritated, and the involuntary muscle brought into activity, e eye-ball is revolved so much, that the cornea is quite lost under the ye-lid."

When he is told to frown there is no motion perceived on the left side f his forehead, but all the expression is on the right side. When ade to laugh, the features are curled up in the expression of laugh-r only on the right side of his face, which presents a singular con-ast with the sad, or lifeless appearance of the left or paralysed side. When a spoon was put into the left angle of his mouth, he could not rasp it; he said that in eating he put the morsel into the right side. he left nostril is not dilated in a corresponding degree with the right; nd the difference between them was most distinctly seen when he at-mpted to sniff up the air or to breathe hard, for then, whilst the right ostril expanded more widely, this one became quite collapsed, or shut p against the air.

The sensibility of the skin over the whole of the head is perfect, and e muscles of the jaws act powerfully. He can move his tongue about all directions.

There is a greater fulness over the left temple and jugum than over e right; there is also a blueness of the integuments, consequent on the jury which he received, but he does not even wince if this part be essed severely. There is an enlarged gland in the hollow under the ft angle of the jaw, and it gives him pain when pressed. The whole ain of the glandulæ concatenatæ in the left side of the neck are enlarged d tender. His hearing is not affected, and there has been no discharge om the ear.

He says that for some days his head has been drawn towards the right de; but this symptom has disappeared, and he can hold his head erect.

> Leeches to be applied before the ear; the face to be rubbed with the camphor liniment; cold lotions to be applied to the side of the head; and a powder of Calomel gr. iv. Rhei gr. viii. to be taken twice a-week. He was instructed to move the eye-lid with his finger over the eye frequently, so as to lubricate its surface.

Nov. 29th.—His head is twisted to the right side, and this is the position in which he said it had formerly been. The head is not merely inclined to the right, but it is also twisted round, so that the right ear presents forwards. On examining the sterno-cleido mastoideus muscle upon the right side, it is found hard and tense, being in a state of *tonic spasm:*

it is the constant action and rigidity of this muscle which prevents the head from being moved to the erect position. It gives him no pain. When he is asked to hold up his head, he throws his head back, but still the neck is twisted towards the right: he can rotate his head in various ways to the right side and to the left, yet he is always checked by the permanent contraction of the sterno-mastoid muscle alone.

Dec. 2d.—This boy has continued in the same state as has been described above; but to-day the spasm of the sterno-cleido mastoid muscle is considerably diminished. He has rubbed the neck with the camphorated mercurial liniment.

Dec. 5th.—He can now hold his head erect, and move it easily in any direction.

Dec. 20th.—Little change has occurred since the last report. The contraction of one side of the neck has not returned. He complained at one time of having some difficulty in swallowing; but nothing could be observed on inspecting the inside of the throat. His face is now in a great measure restored to its natural balance, at least it appears so if we look at him when his countenance is unmoved; but when he begins to speak or to smile, the distortion is visible. Leeches have been applied in succession under the angle of the jaw; he has regularly fomented the side of his face, by holding it over the steam of the poppy fomentation. A blister is now applied under the ear; he has been taking the infusion of gentian with the carbonate of soda.

Jan. 13th.—He has continued much in the same condition, but he is gradually acquiring some more power in the muscles of the face. The swelling under the angle of the jaw is still of a considerable size.

" I shall not now stop to inquire into the affections of the sterno-cleido mastoideus muscle. This muscle is subject in a particular manner to derangements of this kind, which indeed appears by the cases kept in the hospital book."*

No. XXIII.

A man was brought into the hospital who had fallen from a height upon his head. He recovered from the first shock of the accident; but he continued in a dull stupified state, complaining much of headach for a week, when he became comatose, and died. He had paralysis of the muscles of the left side of his face. What was chiefly remarkable, was a constant flow of clear serum from the left ear, so that the concha was always full of it, and the pillow commonly wet. On dissection there was found a fracture extending across the basis of the skull, and passing through the petrous portion of the left temporal bone, tearing the seventh pair of nerves just at its entrance into the meatus auditorius internus.

---

* See the cases of spasmodic affections of the sterno-cleido mastoideus muscle.

The dura mater was torn where it passes from the sella turcica to the petrous portion of the temporal bone; and the cavernous sinus was found infiltrated with serum. There was a considerable effusion of serum between the dura mater and the brain. A communication had been formed through the laceration of the dura mater, and the fissures in the temporal bone, by which this serum had flowed, during life, first into the cavities of the ear, and thence it had escaped outwards through a rupture of the membrane of the tympanum.

No. XXIV.

"When we see a person alarmed without cause, and there is no danger in the case, there is something approaching to the ludicrous in the scene. A physician paid me a visit who had come up from the country in the mail, and had fallen asleep in the night-time, with his cheek exposed at the open window to the east wind. On the morning of his arrival, when preparing to go abroad, he found, upon looking into his glass, that his face was all twisted. His alarm gave more expression to one side of his face, and produced more horrible distortion. Both laughing and crying, you know, depend on the function of the portio dura, but when he came to me he considered it no laughing matter: I never saw distortion more complete. It was difficult to comfort him; but I am happy to add, that the paralysis gradually left him, as I told him it would. I have at present a young lady under my care who has paralysis of the face, and who has received great benefit from galvanism. And I have lately seen an instance of the same kind; the more remarkable only as shewing how the want of expression will injure the finest countenance. I mention these things to remind you of the frequency of the occurrence, and of the necessity of your distinguishing the slighter cases, where the exterior branches of the nerve are affected, from those wherein the cause is deeper seated, and more formidable.

Clinical Lecture on Diseases of the Nerves of the Head. Delivered at the Middlesex Hospital.

"Gentlemen,—Wise men pursue some determined object. I may have erred in having more than one. I confess it has been my desire to combine the philosophy of the profession with the practice of it, because I believe them to be necessary to each other, and both to the true respectability of the individual. Is it not strange that the prejudice of society should run against this association of objects, so natural and so just? But I have felt that it does; for on each occasion that has joined my name with science, it has been necessary to double my attention to practice,—as the vulgar expression is, to work double tides or lose all, by losing that independence which cannot be better attained than through the practice of a profession like ours. I know that I address some who are eager in the pursuit of the higher parts of anatomy—of physiology. Let them take care to preserve that just balance which shall keep their minds capable of subtile inquiries, while their efforts are usefully directed by what they see of disease; for all real improvements in our science are suggested by the occurrences of practice.

"You have asked me to give some observations on these cases of diseased nerves. I will not say that I have any serious difficulties in acceding to this; yet there is some delicacy required, arising from the place in which we are assembled; for I must say nothing that will impede the work of charity.

"The effect of printing and reprinting averments, unsubstantiated from the beginning, is like story-telling. The motive with which they have been made—whether in diversion, mere merriment, or folly—whether in pique, or passion, or mistake—is forgotten, and, like a frequently-repeated story, they take the semblance of truth.

"I remember very early in life to have been taken to visit an old gentleman—such a one as you will never see now, unless on the stage; he had the true square-toed shoes; his coat had square skirts and large sleeves, with a bit of lace; it had no collar, and a flowing wig hung down upon his breast. Though in his doteage, he was to us young folks a wonder and an admiration; besides that, he was a story-teller, and had taught himself to believe the wonders which he told. Among other things, it pleased him to boast of his eyes. He said, that in his youth he could catch a flea by the hair of its back; and, in saying this, he would bring the edges of his thumb-nails together, "sharpen up his brows—like an old tailor at his needle's eye," and look keen and animated, as if the insect were held struggling. His friends hung their heads; but we boys cared not how much the old man might make a fool of himself. With this moral picture I shall proceed to my subject, hoping that some statements connected with it, though groundless, are believed by the writer.

"There is one good that has resulted to me from your request to look over these cases, viz. I have had my attention called to an excellent lecture by my colleague, Dr Watson, upon diseases of the portio dura and the fifth pair of nerves; and I recommend you to peruse it again, for it stands distinguished from all the papers which have been written on this subject, because the observations have been grounded on correct anatomy. Having referred to it, my duty is almost performed; but I think that it may be agreeable to you, in addition to having Dr Watson's paper, to hear the train of reasoning, and succession of observations, by which I was enabled, at last, to come to the conclusions that I arrived at on the functions of these nerves.

"When I lectured upon anatomy, I devoted three weeks to the demonstration of the nervous system; and I very well recollect, on one occasion, having had a dissection before me, in which the nerves of the face, neck, and thorax, were exhibited, in all their apparent confusion; but the order and regularity of which you are now perfectly acquainted with: having given the lecture I went in the evening to the country; and, still reflecting upon the apparent confusion, the seeming irregularity, I said, there must be system here. Regarding the dissection with the principles in my mind which I had long before laid down, I took two sheets of letter-paper, and drew plans of the regular and irregular nerves. The class-drawings from these first sketches have, of course, been long worn out by use; but here [referring to them] are copies of them, the fourth, I may say, which have been made, and which I have borrowed from the London University. This plan, containing the fifth pair and the thirty spinal nerves [presenting it], represents what I termed the *original* or *regular* nerves; and this [exhibiting it] the *irregular, superadded,* or *respiratory* nerves; separating them altogether from the *sympathetic* system. Now, when I placed the nerves included in the one plan over the other, the third over the second, and the second over the first, my pupils understood perfectly well the nature of the seeming confusion and irregularity of the nerves on the side of the neck and thorax. I take one of these drawings away, and I say, here you have all the nerves of the spine regular. Why are they regular? Because their origins are regular. And why are the ten nerves of the head, according to Willis, irregular? Because their origins are irregular. The columns of the spinal marrow, I said, being regular, the roots are regular, and every one spinal nerve is like another. The parts from which the nerves proceed in the brain are wrapt up together, presenting irregularity of the surface; and because the tracts of nervous matter are not expanded and regular, the nerves come off singly, with different powers or properties.

"Long before this (1811) I wrote a little book, put it into the hands of my friends, and had it printed and distributed; it contained (excuse me in saying it) this great principle—that a nerve, whatever its nature may be, cannot perform two functions at once; it cannot convey sensation inwards to the sensorium at the same moment that it carries outwards a mandate of the will to the muscles, whether it be through the means of a fluid, or an ether, or a vibration, or what you will, that it performs its function. Two vibrations cannot run counter through the same fibre, and at the same instant; two undulations cannot go in different directions through the same tube at the same moment; and therefore I conceived that the nerves must be different in their kind. This led me to experiment upon the nerves of the spine; for I said, where shall I be able to find a nerve with the roots separated? Where shall I be able to distinguish the properties of a compound nerve? By experimenting upon the separate roots of the spinal nerves. So, then, taking a fine instrument, the point of a needle, and drawing it first along one set of roots, and then along the other, I found that, as I touched one set—the anterior roots,—it was like touching the key of a piano-forte, all the cords, as it were—the muscles—were in vibration; and when I touched the other there was pain and struggling. That would not do; the animal being alive to sensation, there was confusion here; and therefore I struck the animal on the head, and then I made my experiments clearly: by which it was shewn, that the roots of these nerves were of different qualities, one obviously bestowing *motion*; and, by inference, the other bestowing *sensibility*.

"Now see the course which I took. Having come to this conclusion, that the roots of the spinal nerves were double, in order that each might have a double function, I said—How is the head supplied? Is there any nerve in the head that has a resemblance to the nerves of the spine. Let us see what is the character of the nerves of the spine. I found, on minute inquiry into the distinctions of the two roots of the spinal nerve, that one had a ganglion and the other not. Then, going up to the head, I said—What nerve of the head has a ganglion? The fifth has a ganglion. We have the best authority—not that of name, but anatomical authority—for asserting that there is in the head a nerve, having, like the spinal nerves, a double root, and a ganglion upon one of these roots. See, then, how obviously the road is before us, when this point is ascertained. Now, the function of the posterior root of the spinal nerve, or that which did not excite motion when irritated, may be disclosed to us by taking the fifth pair as a nerve of the same class. Experiments were made upon the three branches of the fifth pair in the face; and what was incomplete in the experiments upon the spinal nerves, was made perfectly clear by them. It was established, that branches proceeding from a ganglion, in all respects the same in structure as the ganglions of the spinal nerves, were the only nerves which bestowed sensibility on the head.

"It has been said—and it has been repeated and repeated so often that I hope and wish, if I do not perfectly credit it, that from the effect of repetition, these parties, like the old gentleman with the flea, believe what they assert—that I gave it out that sensation and motion belonged to the anterior roots. How could that be? The principle upon which I proceeded—the idea which I entertained for many years—that which forced me on to all these experiments—was, that one filament could perform only one function: and for me to say that the anterior roots performed two functions, was just giving the whole matter up. It has been my misfortune to put all these things down in a large, heavy, dear book: were it generally read, which I learn from my bookseller it is not, I should have no occasion, at any time, to vindicate the originality or correctness of my observations.

"When M. Magendie took up this subject, he had in his hands my original paper, in which the classification of the nerves, and the principles on which that classification is founded—" that nerves arising from distinct roots are endowed with distinct functions "—are all stated. He had copies of these plans, which are now hung up beside me. The experiments upon the fifth nerve, which are detailed in that paper, and which were suggested to me by my previous experiments upon the roots of the spinal nerves, were repeated before him, in Paris, by Mr John Shaw, who had on various occasions made the experiment upon the spinal nerves before my pupils in Great Windmill Street, previous to visiting Paris. When M. Magendie performed the experiments upon the spinal nerves, I saw that he went a great deal too far—farther than he was entitled to go by his premises. I saw that he was stating what he could not state from experiments, because his experiments were the same as mine. I had made out part of the subject, viz. that which related to the functions of the posterior roots, by inference, and then confirmed the whole by the decisive experiments upon the fifth pair. He pretended to make the thing clear by experiments upon those nerves which I had puzzled at in vain, in order to make clear by the very same experiments. Then, at an after period, he stated that the anterior roots had both sensibility and motion; and that the posterior roots had both sensation and motion! There the whole is given up: suppose that to be the case, and you have all in confusion. The principle is forgotten, which is, that one filament of a nerve cannot perform two offices which imply an influence conveyed in opposite directions.

" Now, the matter stands beautifully distinct in regard to the spinal nerves; and it is much better that it should come from another than from me. M. Müller has shewn that M. Magendie could not draw his conclusions, as to both sets of roots bestowing the power of motion and sensation, from experiments. He has repeated the experiments with the utmost care, insulating the distinct roots, and observing the effects when they are variously irritated. He has shewn that by experimenting upon frogs, the conclusions which I had announced are confirmed in a manner which admits of no question or doubt; and that one root, the anterior, is for motion alone, and the posterior for sensation alone.

" It is asserted to have been my opinion, that the instinctive motions of the face were alone influenced by the portio dura. See how this matter stands. In the first paper that I gave to the public, in the Royal Society's Transactions, the fifth nerve of the head was described as the spinal nerve of the head, as that nerve which had two roots and a ganglion upon one of them—one root which gave motion, and one which gave sensibility. What motion? The motion of *mastication;* that motion which is common to all animals that live. There is no creature that has jaws, and feeds, but has the fifth nerve, that is to say, a nerve to feel with and to feed with,—the manductory nerve, a nerve for the motion of the jaws in feeding, and for the sensibility necessary to feeding. Whatever may be the mode in which an animal breathes, or however complicated the apparatus of muscles close to which the fifth pair courses, this nerve is limited, as a motor nerve, to the function of mastication. This was one of the principal reasons which induced me to term the class composed of the fifth pair and spinal nerves the *original* system. These were the ideas presented in my first paper, and the same prevail through the whole of this system.

"Then comes the question, What is the meaning of there being a distinct nerve of motion in the face, the portio dura of the seventh, the facial nerve, the lesser sympathetic, as it used to be called? What is the meaning of every cavity within the head, and every surface without the head, being supplied with the fifth, and yet there comes another nerve? Here is the fifth spreading to all parts of the head, yet it bestows motion only on a limited class of muscles—those engaged in mastication—the muscles of the jaws. The portio dura courses close by the pterygoid, and, for many inches, directly over the masseter and temporal muscles; yet no anatomist, however minute a dissector, ever traced the smallest twig from it into these muscles. This is not like a thing of mere chance, but evinces some design. What is the use of this other nerve sent in addition to the fifth? My experiments proved the portio dura to be the nerve of motion to all the muscles of the side of the face, with the exception of the muscles of the jaws;—that it was the only nerve which controlled the motions of the forehead, of the eye-lids, of the nostrils. With regard to the lips, I was led into a mistake in my first experiments, which M. Magendie corrected. I thought that the lips, besides obtaining the power of motion principally from the branches of the portio dura, were also, to a certain degree, under the control of branches prolonged from the motor root of the fifth pair: and this, I conceived, was for the purpose of associating the lips and the cheeks in the combined actions of mastication. I was in error as to the particular branch which is so prolonged to the lips and cheeks—an error into which I should not have fallen, had I examined with more care, before my first experiments, the anatomy of the roots of the fifth pair, as it is given in several of the best German authors. But, by subsequent inquiries, I did find that a nerve, coming distinctly from the motor root of the fifth, the ramus buccalis, was distributed to the angle of the mouth. With this exception, then, I represented the portio dura to be the only nerve of motion of the muscles of the face. It is stated that I called the portio dura the *instinctive* nerve. I do not know what is meant by instinctive nerve: the word is, I believe, not once used in all my papers upon the nerves. I traced the portio dura backwards to its origin: I saw that it neither came like the anterior root of a spinal nerve, nor the posterior root. I found a class of nerves arising in the same line; and so I made out this plan of the irregular or superadded nerves. They go to the eye, the nostril, the tongue, the throat, the larynx, the trachea, the lungs, the œsophagus, the stomach, the muscles that raise the shoulders, the diaphragm, the serratus. Having made that out, what is the conclusion? That they are respiratory nerves; nerves which are going from one source—the source of active respiration—to all the parts necessarily combined in the act of respiration. That was my original idea, and the impression has never been changed.

No. XXV.—*Paralysis of the left Portio Dura.*

"A young female, now a patient of the hospital, is the subject of this affection. The first thing which strikes the observer is the great want of expression, the unmeaningness of the look. I shall read the case through, and then comment on those parts which appear deserving of observation.
"The patient is unable to move the muscles of the left side of the face; she is unable to frown, or close the eye-lid; the eye of the affected side is more prominent than the other; the sense of smell is perfect on this side; there is no deafness, nor alteration in taste or vision. When she attempts to blow, the left cheek flaps loosely; the mouth is accordingly drawn to the right side. There is no want of sensation in any part, and the muscles of mastication act equally on either side. The uvula appears relaxed; sometimes hanging to one side. These symptoms came on during the night, a week ago; but the patient was not sensible of her condition until told of it. She is deriving benefit from leeches and blisters behind the ear, and mild mercurials."

"This is a common case—paralysis of the portio dura. The first thing that strikes you in the case is the unmeaning look. It is very remarkable that all the expressions of passion, whether in the body or the face, depend upon the nerves of respiration. The next thing that I notice here, is the projection of the eye, which occurs in all these cases; and we will pause upon it. Why should there be a projection of the eye? The act of respiration, as you contemplate it, belongs to the higher animals. The function of decarbonization may be performed in different ways. In animals which breathe by means of a thorax, it is by the dilatation of the lungs. In man, other functions are superadded to it, or rather performed through the means of it: such as the act of smelling, coughing, sneezing; actions which become necessary from the very complication of the tubes through which the air must be drawn. You naturally ask, what has the eye to do with respiration? Suppose that you are coughing, or sneezing—suppose that you are exerting yourselves with great power, or doing any thing which shall produce an impulse of blood to the eye, as in vomiting—the eye will suffer, unless it be protected; and nature is solicitous to protect it. How does she do it? By extending the respiratory nerves to the muscles of the eye-lids, giving them an action synchronous, or corresponding exactly with the act of respiration. If, for example, you sneeze or cough violently, you know that you have sparks of fire before the eye. Now it has been imagined that these sparks arose from blood being driven into the retina. No such thing; it is the corresponding action of the muscles of the eye with the act of sneezing that gives rise to it; for it is intended by nature, that the moment you produce an impulse of blood towards the eye, the eye-lids should become firm and tense over the organ, so as to prevent the blood passing into the eye to the injury of its delicate parts. The experiment is exceedingly simple by which this is proved. If, in the dark, you open the eye-lids with your fingers at the moment that you sneeze, there is no spark of fire; the spark arises from the sudden action of these muscles at the very moment that the impulse takes place within; the compression affects the retina just as when you pat upon the eye-ball with the finger. In this woman the eye projects because these muscles of the eye-lids have lost their tone—have lost that property which they have received from the portio dura. The eye-ball, in its natural condition, is held suspended, and duly supported, between the muscles of the eye-lids and the muscles in the orbit: the former failing in their proportion of action, there is a fulness perceptible from a certain protrusion of the eye-ball.

"Now the portio dura is the respiratory nerve of the face—that nerve by which there is a combination of action, not only between the features, but between the face and other parts which are associated in respiration; whether that be simple breathing or the employment of the act of breathing in speaking, smelling, sucking, swallowing, coughing, sneezing, or expression. Many of you have, unfortunately, the opportunity here of observing a person dying. If you have watched the sad scene, you must have noticed that the sense is departing—that the power of motion is going—that sensibility and voluntary motion are at last quite lost; but that the patient respires violently, and at the same time that the chest is heaved up with great power, the muscles of the neck are drawn convulsively, the nostrils are expanded, and the cheeks and lips twitched. Thus there is an action going on, through the influence of this class of nerves, after sense and motion are dead: it is the last system, or they are the last parts to die. Even at length, when the breath is drawn irregularly and at long intervals, and when it finally stops, the last act of life is a twitching of the cheek—a twitching of the neck and of the lips. The last motion that you see in the almost dead body, is the action through this nerve.

"I remember very well, many years ago, when these ideas on the nervour system first occurred to me, that I took the opportunity of explaining them to a great philosopher (Dr Young), who was respected as a man of almost universal information and great intelligence. I took to him the class drawings from which these are copies. Captain Kater, who was present, was very desirous to understand the whole doctrine. I began by saying, "The respiratory nerves of the face." Dr Young was in bad health, and irritable. He said, "Who ever heard of respiration of the face?—that will never do." He would not hear of the idea of respiration of the face. No wonder; as a chemical philosopher, he had only been accustomed to think of respiration as connected with the great function of the oxygenation of the blood. It was a new idea to him to think of the act of respiration as connected with the face; so that I had to explain to him, that if the chest acted by itself, the whole of the tubes by which the air entered would be collapsed—drawn together; that it was necessary that the velum and pharynx, and the chink of the glottis and the nostrils, should be expanded in proportion as the air was drawn in. I said, unless these nerves go to the nostrils, to the pharynx, and to the larynx, you could not breathe; because there would be no expansion of these tubes, by which the air is drawn in, proportionably to the motion of the thorax. You will understand what I mean: that it is necessary to the inflation of the lungs that all the tubes leading to the lungs should suffer a dilatation, or at least be so stiffened by the action of their muscles as not to collapse. In many cases similar to that which I have read to you, when I have made the person close the mouth and draw in the breath by the nostrils, the nostril on the affected side has collapsed; and were this universal to all the openings, and more especially to the glottis, you can easily conceive that the patient would be suffocated. That is what I mean by saying that the act of respiration belongs to the lips and nostrils, to the throat, to the larynx and pharynx, as well as to the lungs; that there is a respiratory nerve to the face. I remember another instance, and a very curious one, too, as marking the necessary extent of the combination of parts in respiration. A young gentleman went up to the College of Surgeons in order to pass. He was examined by my excellent friend Mr Abernethy; who was then in all his vigour of mind, but who was ever a little sarcastic. He asked this young man to tell him the parts that combined in the act of breathing; and when he had enumerated the common parts, he added, "the muscles of the perineum." At which Mr Abernethy sneered, and repeated, "Perineum! what has that to do with it?" My young friend proceeded to explain, that although, in the common act of respiration, the muscles there were not concerned, yet that in all violent excitements of respiration, such as in coughing, sneezing, and straining, he had been taught (and he believed correctly), that unless there were a combined action there, the parts would be protruded; that unless the muscles at the opening of the pelvis were in correspondence with the diaphragm, there could be no protection of the viscera, but a protrusion of it. He added, "I am sensible there is a corresponding action every time I cough or sneeze." My young friend was correct; and here is another instance shewing us that nature is kind and careful in binding the parts together through the nerves, so that every part is supported and protected. However, you may learn from this that it is dangerous to give a new idea to an old gentleman—even to one who, in his earlier life, was foremost in the pursuit of novelty—and that it is better to keep to old theories when you go to the College of Surgeons.

"To return to the case before us, it is stated that the sense of smelling is perfect. Now there is a relation here, and a very curious one. The act of smelling is not simply the exposure of the odoriferous particles floating in the atmosphere to the olfactory nerve; but they must rush with a certain violence over it. There is a sort of double or internal nostril; and a change is produced in the figure of the passage when you breathe simply and when you smell. This configuration of the tube is that which, in the act of taking snuff, gives force to the stream of air upwards. If a man were putting his nose to his snuffbox, and simply breathing, you know what would be the effect—all the snuff would go into the throat; but when he snuffs with the nostril it goes upwards, stimulates the higher part of the schneiderian membrane, and does not go backwards. Thus you see the difference between drawing the air in, in the act of smelling, and the act of breathing. Now this depends upon the action of the muscles of the nostril, and the action of the muscles of the nostril depends upon the portio dura; so that there is a sort of imperfection in the act of smelling, consequent upon the loss of influence through the portio dura, which, but for this explanation, you might conceive had some relation directly to the organs of sense. No; it is only the play of the outward apparatus of sense which is deranged: that is, the meaning, I presume, of this observation,—"the sense of smelling is perfect." In many cases, where this nerve is ascertained to be deficient, the sense of smelling is not perfect.

"The next remark is, that there is no deafness. The first case to which I adverted in proof of the correctness of my opinions was, that of a man who had suppuration before the ear, involving a part of the nerve; and he had paralysis only of the forehead and of the eye-lids. The next set of cases arose from suppuration in the ear and disease of the temporal bone, which you are aware affects the nerve in its very body, previously to its coming out before the ear, and therefore such a cause produces paralysis of the whole face, and deafness. As there is no deafness in this case, and no indication that the root of the nerve is affected in the brain, we may hope that it is a superficial disease of the nerve, or an inflamed gland pressing on it in its course, which causes the symptoms. It is further said, "the muscles of mastication act equally well on both sides;" and this is a very remarkable thing. In some of these cases the muscles of the forehead are wasted, so that there is only a smooth skin over the skull. In old cases of this kind the muscles of the face waste away, and diminish; the integuments are like a piece of parchment drawn over the skull; and the remarkable thing is, that whilst the muscles of the features are thus obviously defective, and absorbed from the want of motion and the want of excitement, the masseter and temporal muscles, which close the jaw, remain entire; because, as I stated, the fifth pair is not only the nerve of sensibility to the head and to the tongue—not only the gustatory nerve—but it has branches which go to the muscles, and those muscles are connected with the act of mastication. All those muscles which either act by sympathy with other parts in respiration, or which are employed under the will in the act of respiration, whether in feeding, drinking, speaking, or in laughing, waste with the injury of the portio dura. The deeper seated muscles, which are supplied by the fifth, do not decay.

"But I am proceeding too far. There are some other cases, diseases of the fifth pair, which are beautiful illustrations of the distinctions of the two systems of nerves. I am sure you must have already observed that these are the very parts which it is important for you to study, because they are necessary to the explanation of the symptoms of many diseases; and perhaps that is the reason why they are more noticed than other parts of the nervous system, which can only be properly pursued by real anatomists, who are thoroughly acquainted with the dissection of the parts, and the complicated functions performed by them, and have time to study the pathology deeply.

Clinical Lecture on Diseases of the Fifth Pair of Nerves, delivered at the Middlesex Hospital.

"I promised you a clinical lecture on the diseases of the fifth pair of nerves, in continuation of that upon the portio dura of the seventh. I think that you followed me on the last occasion, and at least saw the confusion that had reigned over the subject of the nerves. You comprehended the principle which is to extricate us out of that confusion, which I stated to be this: a nervous thread has the same function through all its length; and whatever its endowment may be, it receives that endowment from its connexion with the particular part of the brain or spinal marrow from which it is derived.

"This seems very simple; but what say you to the term *common sensibility*? It was a very general notion heretofore, that the sensibility possessed by all creatures arose from the delicacy of their texture. You find the expression even in Mr Hunter's works, that there is a certain sensibility necessarily resulting from the texture of the animal's body, and common to every part of the body. Now there is no such thing as all this; there is neither a common sensibility, nor are there common nerves. From these apparently harmless expressions, as if all nerves had omething in common, and possessed sensibility, and performed their istinct offices by an appropriate organization of their extremities, arose he confusion which reigned over the whole system. When you made a oper dissection—I am speaking to anatomists—when you followed the rves of the face, the nerves of the neck, the nerves of the thorax; or, was the custom, put the subject into spirits to continue the dissection, labouring and studying for months, and brought it out of the tub, what inextricable confusion there seemed to be. Then came a report from some one, perhaps Walther of Berlin, or Scarpa of Pavia, or Fischer, of a new nerve, or a new ganglion, or a new branch, or a new connexion, having been discovered. But the discovery of new nerves, or new relations, when there was no system and no clew to the labyrinth, only added to the inextricable confusion.

" Now the first principle to be attended to is, that there is no such thing as *common* sensibility. The sensibility of the skin is one thing, the sensibility of the surface of the eye is another; the sensibility of a third part, as the throat, differs again from these; the sensibility of internal parts differs from the sensibility of external parts; and each degree and kind of sensibility is benevolently bestowed for a definite purpose. The textures of the frame would be destroyed by our common occupations, were they not guarded by a power better calculated to preserve them than if we were defended by threefold brass,—sensibility to injury; that sensibility which is in the skin, and which animates us when any thing pricks or tears; that sensibility, more especially, to the degree of heat which is around us. What would be our condition were we not thus kept continually upon the alert, and alive to the change of temperature in the atmosphere around us? What, I would ask you, is the condition of the paralytic? I speak to you who know well how frequently the paralytic comes into the hospital burnt. He sits over the fire; he does not know that the degree of heat is above what his leg or his arm can sustain, and the part suffers. Now to such dangers we should all be exposed, were there not wisely and benevolently instituted an appropriate sensibility in the skin to heat, warning us of the slightest changes in the temperature of the atmosphere.

" When you compare the external and the internal parts, you find that it is not a common sensibility which they partake of. What would be your condition were the parts within and around the knee-joint, or the ankle-joint, as sensitive as the surface of the body? You would be creeping home as if you had inflammation in the joints; you could not walk, if the parts that were bruised in the motions of the body possessed sensibility like the integuments. On the other hand, what would be the consequence if there were no sensibility there? You would have no guidance as to the measure of your exertions; you would have nothing to tell you how much power, in using the limbs, was compatible with the texture of your body; you would be subject to injury, not from without, but from within—to rupture and to laceration. Thus you will ever find that the sensibility which is to guard the body is suited to the particular part. Take again, for example, the eye; there you have a sensibility not like that of the skin, not like that of the bone, or of a joint, or of a part situated internally, but yet it is of that exquisite degree which will be excited by the slightest motion of an insect's wing. You must have observed that you may put your finger on the surface of the eye without producing the degree of pain which a particle of dust, or a hair of the eye-lashes will do. What would be the use of this lachrymal apparatus, the little stream that flows over the surface of the eye, this fine mechanism, by which the eye is closed and protected from the light particles floating in the atmosphere, unless there were not only a high degree of sensibility, but a sensibility of a kind suited to the impressions which these particles make. Light matters, which fall upon the hand, or skin of the face, and inform you of nothing, will, when they light on the surface of the eye, produce excitement, and a protecting motion of the eyelids.

"Then, again, it has been supposed that the different organs of sense are susceptible of their peculiar impressions, because of the delicacy of the extremities of their nerves. That is a great mistake; it is just the mistake belonging to the term common sensibility and common nerve. At this time there is an expression of approbation of an observation of M. Magendie's, running the course of the journals, and the systematic authors of the day: he tells you, that the sensibility of the surface of the eye to the needle of the oculist is one thing, but that the sensibility of the expanded retina is another; and that, when the latter is struck by the needle, there is a flash of fire. Now it is not very creditable to the class of men to whom M. Magendie is addressing this, that they should not know to whom this remark belongs; because it is not merely curious in itself, but interesting as associated with those other observations which have led to things of more importance. I should have expected that, when such a fact was announced by M. Magendie as his own observation, some friend would have tapped him on the shoulder, with a "doucement, tais toi, mon ami!—did you not tell us that you had a little English book in which this is stated?" From this work I will read you two paragraphs: †

"'In this inquiry it is most essential to observe, that while each organ of sense is provided with a capacity of receiving certain changes to be played upon it, as it were; yet each is utterly incapable of receiving the impressions destined for another organ of sensation. In the operation of couching the cataract, the pain of piercing the retina with a needle is not so great as that which proceeds from a grain of sand under the eye-lid; and although the derangement of the stomach sometimes marks the injury of an organ so delicate, yet the pain is occasioned by piercing the outward coat, not by the affection of the expanded nerve of vision. If the sensation of light were conveyed to us by the retina, the organ of vision, in consequence of that organ being as much more sensible than the surface of the body, as the impression of light is more delicate than that pressure which gives us the sense of touch, what would be the feelings of a man subjected to an operation in which a needle were pushed through the nerve! Life could not bear so great a pain.

---

† Idea of a New Anatomy of the Brain, by C. Bell. 1811.

" 'But there is an occurrence during this operation on the eye which will direct us to the truth: when the needle pierces the eye, the patient has the sensation of a spark of fire before the eye. This fact is corroborated by experiments made on the eye. When the eye-ball is pressed on the side, we perceive variously-coloured light; indeed, the mere effect of a blow on the head might inform us that sensation depends on the exercise of the organ affected, not on the impression conveyed to the external organ; for, by the vibration caused by the blow, the ears ring and the eye flashes light, while there is neither light nor sound present."

" M. Magendie might have gone farther on the same authority, for I then extended my remarks to the other organs of sense, to illustrate the distinction in the functions of the different nerves. Suffice it then to say, that there is sensibility bestowed upon every part according to the necessities of the organ, and for the beneficent purpose of defending the delicate textures of the frame; and as to the surface of the eye, the sensibility which is conferred upon it has a relation to the protecting apparatus, so that the fine structure and transparency of the globe may be preserved; while the sensation of the retina is adapted to the varieties of light and colour only.

" With regard to the term *common nerve*, we now see its incorrectness. So far from all the nerves being sensible, or all being endowed with the same sensibility, it is found that certain nerves have no sensibility at all. I recollect perfectly well the occasion when it occurred to me, that this might be predicted merely from a comparison of the different qualities of the nerves of the senses. But it was afterwards put to the test of experiment—by selecting the roots of the spinal nerves, touching one root with the point of a needle, and then touching the other, and thus ascertaining that there was a difference between them. And when once it was ascertained that the nerves going out from the spinal marrow had combined within them different sources of energy,—and when it was shewn that these different sources of nervous power resulted from their having different roots,—what had we to do next? Nothing more than to study the anatomy; and I repeat it, that the anatomy will never fail you. Experiments frequently fail, because they take a colour from the fancy; they suit themselves to the expectations of the experimenter. But anatomy is substantial: you will never be deceived if you attend to the anatomy of the nervous system, and consider thoroughly the functions of the organs to which the particular nerves are distributed. When it is ascertained that the spinal nerve has a double root and a double endowment from this double root, and is in this respect a common nerve, because it has two qualities combined in it by means of its roots, you have only to observe the columns from which the roots arise, and trace them up to the brain, to be satisfied of their correspondence throughout their whole course. From the column of nervous matter which gives rise to the nerves of sensation, you have only nerves of sensation; from the column which gives rise to the nerves of motion, you have only nerves of motion.

"Then comes the inquiry, naturally arising out of these facts—What nerve in the head is like the spinal nerves; what nerve has two roots? You know well, that of all the nine cerebral nerves of Willis (you leave out the sub-occipital, or tenth, because it has a double root, and is a spinal nerve), that there is no other nerve in the head which has a double root but the fifth. Then you place the fifth and the spinal nerves in contrast; you mark the resemblance in the manner by which the roots arise; you observe the ganglion of the fifth, that it is totally different in structure from the ganglion of the sympathetic, for example; that while it differs from the ganglions among the visceral nerves, it has a perfect resemblance to the ganglion of the spinal nerve. The two roots, and a ganglion on one of the roots, the other passing over the ganglion, and keeping free of it:—what does all this imply, but at once, and in a single word, that the fifth nerve is a spinal nerve; that the fifth nerve is a nerve giving to those parts of the head to which its two roots are distributed, the same compound properties which are given to the body by the nerves of the spinal marrow. The first time that I ever expressed this in writing, though I had often referred to it in lecture, was in the first paper which I gave to the Royal Society. I called the fifth the nerve of sensibility to the face, to the cavities and surfaces of the head, to the tongue, and to the salivary glands, and the nerve of motion to the muscles engaged in manducation: in short, I shewed that it was "the nerve of mastication and sensation." The same nerve which you may find in the caterpillar going to the mouth. As the chain of nerves and ganglions in these lower animals performs the office of the spinal nerves and spinal ganglions, giving sense and motion to the body, so do the ganglion and nerves around the mouth perform the office of the fifth nerve, giving sensibility and motion to the mouth, and the filaments around it. Such was my original idea. Here, in the highest link of the chain of animal beings, as in the lowest, the nerve is subservient to the same functions;—it is the nerve of taste, and of the salivary glands —of the muscles of the jaw, and of sensibility to the lips. When we had divided the fifth nerve in the ass, the animal could no longer gather its food, because it could not feel with its lips, and all the motions of its jaw had ceased. So that the anatomy of the human body, the experiments upon animals, and finally, our experience in disease, led to the conclusion, that from the most simple vertebrated animal up to the highest individual in the scale, the fifth nerve was to be considered the same nerve, and that it served precisely the same purpose in all.

"The best way in which we can proceed, is to read a case of disease of this nerve; and I believe that we are indebted to the house-surgeon, Mr Elwyn, for the drawing up of this case.

No. XXVI.—*Case of Disease of the Fifth Nerve.*

Mary Ann Webb, at present in the hospital, is 57 years of age. She has loss of sensation in the right side of the face and neck. It begins at the vertex, and extends as far as to an inch above the clavicle on the fore-part, and it reaches behind as far as to the vertebra prominens; so that the defect of sensibility is bounded by the median line. There is, however, one part above the parietal bone, which, although it is deprived of sensation, is the seat of acute pain. The conjunctiva of the right eye is insensible, and there is a mistiness of the eye, from the surface being devoid of secretion. The sense of smelling is impaired.

"I must observe to you, gentlemen, that it is not easy to say when the sense of smell is impaired. It appears that the narrator put ammonia to the nostrils. There is not much odour in ammonia; its stimulating effect upon the fifth pair is great, but not necessarily upon the first. Besides, it is very difficult to confine the impression to one nostril. The effluvia circulate backwards, so as to affect the other side of the cavities of the nose. You require to distinguish the sensibility which would excite sneezing—that is, the mere irritation of the schneiderian membrane, from the excited state of the olfactory nerve. You must have all experienced that a slight inflammation in the cavity of the nose destroys the power of smelling; but it does not make you less susceptible of irritation and sneezing: so that there is always the distinction to be observed between the sense bestowed by the appropriate organ of smell—the olfactory nerve—and the sensibility of the nostrils (appropriate also) which is bestowed by the fifth pair. But to proceed with the case.

"The taste, and the sensation of the tongue in the right half, are also gone. In chewing, she places the food in the felt cheek, for she does not feel on the other side. She uses her finger to remove the morsel from between the cheek and the gums, instead of the tongue; and when she swallows, she feels the broth or tea only on one side. The muscles of the jaw are apparently not affected.

"I find, however, a note here by another hand, 'not correct.' You would naturally suppose that the muscles of the jaw were not affected, so long as the patient moves the jaw; but you cannot fail to observe that the muscles of both sides of the jaw close it; and the jaw may be closed when those of one side are quite inactive. The only way in which you can ascertain that there is loss of action in the muscles of one side, is by making the patient close the mouth, and then shut the teeth with a further effort, as it were to break something with the teeth; and then you will find that the temporal and masseter muscles rise up and become rigid on one side and not on the other. But as long as you try to ascertain it by the opening and closing of the mouth, the motion of the coronoid process of the jaw produces an apparent motion of the muscles which are inactive.

A fit, occurring seven months ago, is said to be the cause of this woman's condition. When she recovered from the fit, she says that there was a deadness of the right side of the face, and a distortion of the countenance. However, the condition of the face became natural in the course of a few days; and she is unable to say which side was deprived of motion. She continued to be troubled with headach. The speech is not affected, though it was at one time; she felt some difficulty in pronouncing her words, and could not speak as fast as had been her manner before.

" Now, the first remark that I shall make on this case regards the acute sensation of pain in a part over the parietal bone, when all around it was insensible. I beg your attention to this circumstance, which is apt to puzzle the inquirer, and greatly to distract the patient. When there is disease of the fifth pair of nerves at the root, the patient will tell you that there is exquisite pain in one spot, at the same time that she is quite insensible to injury of any kind upon the part. The explanation is this: —the disease embracing the root of the nerve, gives rise to pain, which pain is referred to the tactile extremities, that is, to the surfaces of the face or head, to which the branches of the nerve are distributed. I can supply an illustration of this from your own experience. As we go round, you see a woman with disease of the rectum, attended with pain in the leg and foot. Now, in that case the inflammation has engaged the ischiatic nerve in the pelvis, and the impression originating there is felt as if it were in the part to which the nerve is distributed.

" The next circumstance of interest in the case, is the want of sensibility in the tongue. We are hardly aware of all the happy combinations in the motions of parts, or of the fineness of the sensibility which governs these motions, until there be some defect in them. You do not think, for example, of the necessity of a combination being established between the elevator of the eye-lids and the rectus superior of the eye-ball, until you see a little disagreement in their actions, or want of consent; then you find that the person, when he looks up, turns the pupil under the eye-lid, and sees nothing. You are hardly conscious how much you enjoy through the common sensibility of the tongue: I mean the sensibility to touch; for the tongue is not only sensible to taste, but sensible, in the most exquisite degree, to touch. The guidance of the tongue, and the action of its muscles, through the sensibility of the surface, is seemingly so simple an act of the will, that you never think of it as a combined operation of two distinct faculties. Yet it must be obvious to you, that if you possessed the motions of the hands and fingers, without the sensibility of the fingers, and thrust your hand into your pocket to take out a piece of money, you could not grasp it any more than if you took a pair of pincers for the purpose; that is to say, you want that relation which is established between the sensibility of the fingers and the motion of the hand. And this is the reason why certain metaphysical writers have mistaken the matter, and have said that the sense of touch is different from all the other senses; inasmuch as it is active, they say, and there is a property going from the sensorium to the hand. Indeed so there is; you do not merely feel through the sensibility of the points of the fingers, but you grasp by an effort, which is an influence passing outwards: but then, it is not an effort of the sense of touch, strictly speaking; it is only an instance of the necessity of the muscular action combining with the proper exercise of the sense of touch. The same is exemplified in the tongue: the motion of the tongue is perfect in this case; the influence of the ninth pair of nerves is perfect; there is no difficulty in moving the tongue to the side of the cheek, but she does not know that the morsel is there. In other cases that I could read to you, the patient did not know that the meat was in the cheek till it became putrescent and offensive to others; but this patient, knowing that she is subject to have things lodged there, takes care to remove them; and she regularly puts in her finger, as she might her tongue, and displaces the morsel from between the teeth and the cheek.

"The next thing that I should dwell upon here, is what I have already partly explained; namely, that the muscles of the jaw are not apparently affected. But I am not quite satisfied about this being correctly stated: I am afraid that the time is past for ascertaining the point quite satisfactorily, because, under the treatment of her physician, she has greatly improved in all her symptoms; yet I should like you to inquire whether the masseter and temporal muscles have not been affected here, as well as the sensibility of the skin.

"But, on the whole, in regard to this case, I am not satisfied that it is one of those pure cases of affection of the fifth pair, or that it is a disease merely of the trunk of the fifth pair. Disease in the nerve does not come on with a fit, which this did. You will observe that there is insensibility, not only in that part of the body to which the branches of the fifth pair are sent, but further down, in the nape of the neck, and along the back and side of the neck. If you find that the insensibility precisely corresponds with that part of the surface of the head which you know from the anatomy of the fifth to be supplied by its branches, it is a fair inference, that it is the root of this nerve which is affected; but if you find that the insensibility extends beyond these boundaries, you must either conclude that the disease involves the roots of more nerves than one, or that the disease is deep in the brain, so that it affects more than the fifth nerve. From the whole history of the case, I consider this not o be an affection of the nerves as they are going out through the base of he skull, but an affection of part of the brain itself."

The concluding part of this Lecture has been transferred, as it belonged o a dissection which has been already given.

The four following cases were related by Dr Watson in a Lecture de-ivered by him at the Middlesex Hospital, and reported in the Medical Gazette.

No. XXVII.—*Paralysis of the Face.*

" A housemaid, Jane Smith by name, twenty-eight years old, presented herself here as an out-patient, with the following symptoms. She had ost all power of moving the right side of her face. When she endeavoured to raise her eye-brows, the right side of the forehead remained smooth, and the left was wrinkled. When she attempted to raise her eyes, the right eye was but partially covered, the eye-ball rolling upwards, and carrying the cornea within the curtain of the upper lid, which descended a little to meet it. When she smiled, the right side of the face remained immovable, and it wore at all times a blank and expressionless character. When she was told to perform the action of blowing, the right cheek was puffed out like a loose bag, and the breath issued, whether she would or no, at the right angle of her mouth. The same hing happened with her food and drink : she could not prevent their escaping at the right corner of her mouth, nor could she convey morsels of food from the right to the left cheek without the aid of her hand applied externally in support of the paralysed cheek. The masseter and temporal muscles acted, however, as strongly on the one side as on the other; and the sensation of the palsied parts remained perfect. There was no paralysis of any other part of the body."

No. XXVIII.—*Disease of the Fifth Pair.*

" Ann Church, King's ward. The symptoms for which this woman sought admission into the hospital were intense pain, with some swelling, of the right temple, and extending generally over the right side of the face and head. It was soon discovered, however, that although she complained of most severe pain in these parts, they had entirely lost their ordinary sensibility to external impressions. She felt nothing when her forehead, or cheek, or nose, or chin, was touched on that side. In short, there was complete anæsthesia of the right half of the face, the insensibility being very exactly limited to the right half, and terminating abruptly at the mesial line. It was remarkably evident in a part with respect to which we could not be deceived, even if there had been any reason (which there was not) for suspecting the truth of the patient's statement. The surface of the eye-ball is proverbially sensitive, especially to slight impressions. But you might place your finger upon this woman's right eye, or you might brush it with a feather, without giving her the smallest pain, or producing any sensation at all; whereas, on the left side, the slightest touch caused involuntary shrinking, and closure of the eye-lids, and lachrymation. She declared, also, that she had no feeling in the right half of her mouth; she neither tasted sapid substances, nor was at all conscious, from any sensation produced by them, that they were placed there. Her lips on the same side were equally destitute of sensibility; so that, when she drank, having no perception of the contact of the cup with her lips beyond their middle point, she felt as if she were drinking from a broken vessel.

" Besides this default of sensibility, the power of contracting the masseter and temporal muscles was entirely abolished; no swelling of the masseter or temporal muscle on the affected side took place when she forcibly closed her jaws. There was no other paralysis. Some difficulty in the movements of the face on that side existed, on her admission; but this depended wholly upon the swollen state of her cheek and jaw, and disappeared as the swelling subsided. At all times she was able to depress, or draw backwards, the angle of the mouth on that side.

" The insensibility was beginning to yield, and the pain had very much abated, after cupping and leeches on the temple, when erysipelas came on, spreading, apparently from a blistered surface behind the ear, all over the right side of the face and head, and afterwards extending down the neck. With this there ensued much fever and delirium, and I began to be anxious about the event. Until this accidental supervention of erysipelas, there were no symptoms present that indicated any positive affection of the brain or its functions. She is now, I think, out of danger, but very feeble, and teased by abscesses in the cellular tissue of the eyelids and neck, but she has regained a considerable degree of sensibility in the parts that were before without feeling, although (which is curious) the palsy of the masseter and temporal muscles continues absolute.*

No. XXIX.—*Paralysis of the Face.*

" Some of you will recollect one of my patients (Richard Hills) who was in Pepy's Ward about this time last year: in him the same kind of paralysis (of the face) seemed to have been occasioned by a mere shock or jar. He was a coachman; and one day, when he was off his box, his horses started away, and he ran to their heads to stop them, but was thrown down in the attempt, striking his right hip and elbow. He received no blow on the head at all. Three hours afterwards he found that he could not spit properly—that he could not avoid spitting on his clothes on one side, and that he could not whistle. Another circumstance worthy of notice took place in this man, which often, though not always, happens in these cases, and which I did not mention before. He remained for about two months in the hospital, and regained during that time, in some degree, the power of exercising the affected muscles; but he still was unable to close the right eye-lids. The eye itself was unharmed. After he was made out-patient, he resumed his functions on the coach-box, and his eye, permanently half open, was more exposed to colds and currents of wind than it had been while he was here. Moreover, he got drunk; and he soon presented himself again, with universal redness and inflammation of the conjunctiva.

---

* Since the lecture was delivered, this patient has recovered in a great measure the use of these muscles. Her general health is quite restored, and the sensibility of the face is nearly as perfect as ever.

"That the greater number of cases of this kind are free from serious peril, is a fact of great practical importance. It enables us to quiet the alarm of the patient and his friends, and regulates, in many instances, the treatment, rendering it less rigorous than it might and should be if the palsy were really the harbinger of apoplexy. At the same time, you ought to know that a similar limitation of paralysis to the particular muscles supplied by the portio dura, is sometimes (though rarely) observed, when the disease has a more inward origin—when it affects and involves the brain itself.

No. XXX.

"In the latter end of September, in the year 1829, a gentleman became my patient, in whom complete palsy of the left side of the face had existed for a day or two. I need not describe the appearance and symptoms which depended upon the paralysis, for they were precisely the same as were presented by Jane Smith, and they are always, and necessarily, very much alike. But though the *palsy* was strictly limited to this set of muscles, there were other symptoms present which indicated that the interruption of the function of the portio dura was connected with some morbid condition within the cranium—nausea and vomiting, twitchings of the muscles of the *other* side of the face, great drowsiness and a slow pulse, forty-eight only in the minute; he lurched also, and staggered as he walked; but he distinguished this from the reeling of vertigo, and denied the latter sensation altogether. His previous history did not tend to diminish the fears which his actual state occasioned.

In the preceding February he had been attacked rather suddenly with intense pain just above the right eyebrow, and became extremely drowsy. Being desirous to excuse himself from a dinner engagement, he found that he was unable to write a proper note; he could not remember how he ought to express himself.

He had another attack of the same kind in May, the same severe pain over the right brow, with great drowsiness and confusion of mind. He could not recollect many familiar words. On both these occasions the symptoms soon gave way to treatment directed to the stomach and bowels.

Cupping behind the ear, blistering, purgatives, and small doses of calomel continued till the gums were slightly sore, removed the paralysis, and all the other symptoms, in about ten days, and he is now in perfect health.

But you have lately seen an unequivocal example of the same combination of internal disease with palsy confined to the muscles that are governed by the portio dura, in the person of Samuel Dovey. This man, a tailor, aged 57, was admitted into the hospital, on the 26th of February last, with complete palsy of the muscles supplied by the nerve in question on the right side and of no others. There were symptoms enough, however, to shew that some serious morbid process was going on within the skull. He suffered intense headache, more on the left than the right side; was dizzy and staggering, and could not get to the ward without being led.

The palsy had come on about ten days before, in the night. He found when he came down stairs the next moruing that he could not spit as usual, and his friends observed the unnatural state of his features. He had no fit nor loss of consciousness, but he fancied that his memory was failing. At the time when the paralysis was first noticed he had some numbness and tingling of the right arm, extending to the two last fingers. He was quite deaf in the right ear.

I had him cupped, cold lotions were applied to his head, and his gums were made tender by calomel. In a few days the pain in the head increased, and he became affected with drowsiness, approaching to stupor. He was then bled. The coma went off soon after the bleeding, but was succeeded by violent delirium; and this again subsided after free purgation. He began occasionally to pass his stools in bed, and unconsciously. On the 16th of March he again fell suddenly into a state of stupor. You saw him at that time, breathing stertorously, his lips flapping to and fro with each act of respiration, his face and head red, hot, and turgid, the temporal arteries distended and throbbing. I should have stated that at all times there was a sharp and peculiar bruit accompanying the contractions of the ventricles of the heart; the sound much resembled that made by drawing the finger forcibly along a piece of stretched silk. The temporal artery was opened at once, and about sixteen ounces of blood flowed freely in strong jets; the pulse then became feeble; the turgidness of the countenance subsided; and the blood just continued to well out, but the stertor remained. In a few hours, however, he was much better, and became sensible; the palsy was unaltered. The arterial blood was covered with a thin but distinct buffy coat. He lived till the 29th, being for the most part drowsy, sometimes completely comatose, but generally capable of being roused, and answering rationally when spoken to. For some days before his death it was observed that his arms were constantly bent upon his breast, and that whenever they were forcibly extended they returned immediately to the same position, apparently without any exercise of volition on his part, as soon as the extending force was withdrawn.

We examined his body on the 30th, thirteen hours after death.

(Here follows the description of the appearances within the thorax.)

But it is to the examination of the head that I chiefly wish to recal your attention at present. When the skull-cap and dura-mater had been removed, you saw that the surface of the brain was quite dry and flat; the sulci between the several convolutions were scarcely apparent. Whenever you meet with this dry and level condition of the surface, you may be sure of finding some cause of pressure within. Accordingly, the left lateral ventricle was enormously distended with clear serum, and remained of a vast size when emptied; while the walls of the ventricle on the right side were forced into close apposition by the pressure of a tumour which occupied a large portion of that hemisphere, the central part of the tumour being rather posterior to the centre of the hemisphere. The posterior portion of the tumor was of a red colour and soft; centrally it had a light orange tint, and a spongy or cellular structure, and its anterior part was hard, homogeneous, and pearly in appearance. The tumour was about three inches in length, nearly two in breadth, and of considerable thickness. By a subsequent section, an apoplectic clot, as big as a hazel nut, was discovered at its under part. I presume that this was the result of the rupture of some small vessel in the progress of the disease, and that the effusion of blood took place at the period of the deep coma on the 16th. The arteries at the base of the brain were partially thickened, the thickened portions being white, opaque, and dilated.

The further prosecution of the dissection afforded a most satisfactory explanation of the deafness and the partial palsy which had been noticed during the life-time of the patient. The portio dura, and the portio mollis, where they emerge as distinct cords from the medulla oblongata on the right side, were adherent to each other; the portio dura was both harder and larger than the corresponding nerve of the opposite side, while the portio mollis was diffluent and wasted. The same change was traced to their entrance into the petrous portion of the temporal bone. Immediately over the medulla oblongata, and in a vertical line above the point of emergence of the seventh pair of nerves, a nipple-like portion of brain projected downwards, and had apparently communicated pressure to these nerves; and this projection from the lower surface of the brain seemed to have been produced by the general pressure resulting from the growth of the tumor.

No. XXXI.—*Case communicated by Mr C. W. Bell.*

Edinburgh, Royal Infirmary.
Dr Gregory.

Thomas Miller, an elderly man, came into the hospital for jaundice: he had a remarkable distortion of the face, the mouth and cheeks were drawn towards the left side, the right ala of the nose was motionless, the right eye staring wide, and the eyebrow and forehead of that side smooth, motionless, and without expression. He had nevertheless perfect sensibility over the whole head, and the masseter and temporal muscles of that side could be felt in powerful action when he chewed.

He said that he had been subject to constant discharge from the right ear from boyhood till five years ago, when the running ceased: he lost the hearing of that ear, and his face assumed the extraordinary appearance which it now presents; and he was obliged every now and then to draw back the mouth with his fingers.

On Tuesday 13th July he died of the disease for which he was received into the hospital; and on dissection, besides the other appearances connected with his complaint, it was found, on examining the head, that a small tumor, like two or three drops of spermaceti, having a pearly lustre, pressed upon the seventh nerve, just as it enters the meatus internus; the nerve appeared slightly diminished in size as it emerged from the stylo-mastoid foramen. He had never had any head symptoms.

I was favoured by Dr Gregory with a sight of the preparation, of which I made a sketch. The temporal bone was carious, and the frontal partially so.

No. XXXII.—*From a Paper by Dr Romberg on Paralysis of the Face.*

In January 1835, a child was brought to me, aged two years, exceedingly emaciated in consequence of mesenteric disease, and having a purulent discharge from the right ear. But at first sight the condition of the mother attracted my attention more than the hopeless state of her child. She had suffered during the last ten years from a convulsive affection of the right nervus accessorius, through which the head was drawn towards the right shoulder, whilst the face was inclined to the left side, with the chin projecting outwards. As I was noticing the case of the child to Dr Philipp, who was assisting me, and observing how, in similar cases, paralysis of the facial nerve was produced, the mother interrupted me by saying, "My child also has a distorted countenance when it cries."

I pinched the child on the body, and it immediately cried with the right half of the face only, the left remaining as inexpressive as a mask. The corrugator supercilii of this side did not move in the least, whilst the right brow was furrowed. The left eye-lids were separated one from the other, and through this gaping of the lids the left eye was rolled upwards in crying, whilst the other closed itself; this was also the case in sleep, as the mother informed me. The left nostril is collapsed, and the point of the nose and the left angle of the mouth are inclined to the right side. When the countenance was tranquil there was nothing to be remarked but a greater separation of the eye-lids (by which means the left eye appeared to be larger than the right), and an inclination of the nose to the right side. In a few days the child died.

The examination of the encephalon was conducted by Dr Henle, the prosector of the (Berlin) anatomical school. Upon the arachnoid membrane, over the surface of both hemispheres of the cerebrum, were a number of small round granulations, which composed a mass resembling hardened pus. In the cortical substance of that part of the middle lobe which rests upon the left temporal bone, there was a deposition of tuberculous matter which entered into the medullary substance to the depth of a quarter of an inch. There was also a tuberculous matter deposited in three spots on that part of the dura mater which covers the left temporal bone.

After the removal of the dura mater, the temporal bone was seen to possess a brown colour, and worm-eaten appearance; it was immediately taken out and examined. It was carious almost throughout, there were no remains of the malleus or membrana tympani; so that the pus had free exit from the cavity of the tympanum through the external auditory canal. The facial nerve appeared to be sound in that part which is called the knee, but a portion of it was disorganized in the Fallopian canal.

No. XXXIII.—*Case of Partial Paralysis, Middlesex Hospital.*

Mary Brown, æt. 15, a pale and emaciated girl, was in the Physicians' Ward for an obstinate constipation of the bowels, and for some symptoms of paralysis.

We learn that, when four years old, she fell and struck the back of her head: she was stunned by the fall, and remained insensible for a short time. She was for two days sleepy and lethargic, when it was observed that the left side of the body was completely paralysed: this paralysis continued for fifteen months without any amendment taking place. After this period she improved slowly, and at the end of another twelvemonth she was so far recovered as to be able to walk: the disease then remained stationary, and no alteration appears to have taken place up to the present time.

"She is in a very feeble condition: the paralysis seems now to be confined to the left side of the face, with the exception, however, of the left arm, which is much weaker than the right. There is not only a want of power in the muscles of the left arm, but the sensibility of the extremity is evidently impaired, for she is unable to perform those actions which require the combination of the delicate sense of touch, and the finely-regulated action of the muscles. She cannot pick up a pin.

"The sensibility of the left side of the face is but little affected. The parts supplied by the portio dura on this side have lost all their motion; the mouth and right ala of the nose are dragged towards the right side. She is unable to move the left side of her face, even in the slightest degree. When she smiles, this side is void of all expression, and is in strong contrast with the opposite side. She says that the food is apt to lodge on this side of the mouth, betwixt the cheek and the gums. The inability to close this eye-lid affords us a good opportunity for observing the motion of the eye-ball in the act of winking. Every time that she winks, the uncovered eye-ball of the left side is turned up, and as quickly descends again. This motion of the eye-ball is performed with extreme velocity, but at the same time is so obvious and demonstrable, that the most careless observer could not overlook it. In order to see the same motion of the eye-ball performed more slowly, she was desired to attempt to close her eye-lids; when it was observed that the eye-ball was turned up in the same manner, and remained so until she again unclosed the eye-lid of the right side. The senses of taste and hearing on this side are impaired; the sight is dim, but she sees the whole of an object. The tendency to constipation of the bowels was coeval with the paralysis, and no doubt depended upon it."—From the House-Surgeon's Case-Book.

This is one of the cases where the brain has been so influenced as to affect the whole nerves, both of sensation and volition, of one side. As to the fact of the rolling of the eye, it is conclusive.

The following note was drawn out by Mr A. Shaw, then a pupil:—

No. XXXIV.—*Case of Partial Paralysis of the Face.*

"During the last course of lectures in Windmill Street, while Mr Bell was giving his lectures on the Nervous System, a gentleman, who had been a pupil of another school of anatomy, came to consult him on his own case. His face was distorted, the muscles being completely paralysed on one side; he retained the sensibility equally on both sides. He presented the exact case which we had heard described at lecture as an affection of the *portio dura* of the seventh pair of nerves.

"We observed the eye-ball of the side affected. When he winked, the eye-ball revolved upwards and inwards, and there was no doubt or difficulty in observing this movement, as the eye-lids remained wide open at the time when the eye-lids of the other side contracted.

"He ascribed the origin of this affection to having imprudently sat without his coat reading at an open window, after being fatigued and heated with a long ride. This paralysis of the face, and a stiffness of the neck, attacked him nearly at the same time.

"We (the students present) shewed him the dissection of the nerves of the face, which had been prepared for lecture. He examined it with great interest, and the explanation of his case was apparently new to him."

I have lost the other notes on this case.

If the reader will turn to authors upon the diseases of the eye, under the head of *Lagophthalmia*, he will see how mistaken the practice is in applying the remedies to the eye-lids in this disease, when the cause may be in the temporal bone, or in the glands near the angle of the jaw, or some remote nervous irritation. Oculists, as Richter, for example, when the eye-lids do not close, recommend rubbing the eye-lids once or twice a day with a drop or two of fennel oil, frictions upon the eye-lids with the tinctura cantharidis, blisters near or immediately upon the eye-lids, the application of cold water to the eye by means of compresses wet very often in the course of the day, &c.

No. XXXV.—*Case of Paralysis of the Face.*

"January 2. 1827, Daniel Stalder accompanied his wife, who had a paralytic stroke, to the Middlesex Hospital. It was observed that the left side of his face was much distorted, and there was great wasting of the muscles. He was examined by Mr Bell, before the pupils of the hospital, and it proved to be a case of paralysis of the portio dura. The two sides of his forehead presented a very striking contrast: the right side was furrowed with deep wrinkles, which were more strongly marked when he frowned; and a large fold of the skin was prolonged down upon the same side of his nose, which marked the descending slip of the occipito-frontalis muscle. The left side of his forehead was perfectly smooth, the skin appearing to be stretched tightly over the bone, and there was no motion of the integuments in the act of knitting or elevating his eye-brows. His left eye-lids were quite motionless. When he was desired to wink, this eye remained open, and the cornea was elevated so as to be quite hid under the upper eye-lid. This eye appeared a little duller than the other, yet he says he never had any disease in it. He cannot see so clearly with it as with the other eye. The left nostril is collapsed, and has not that fulness which the right possesses. He seems to retain some power of acting with his cheeks, as in whistling there is a slight quivering observed. Although his lips are dragged to the right side, they do not appear to be totally deprived of muscular power: he can grasp the point of the little finger pretty firmly when it is introduced into the left angle of his mouth. The muscles of the neck are perfect: the fibres of the platysma myoides start out when he puts it into action. The skin has its natural degree of sensation. He states that he has had this affection since he was a child. He has had no deafness; nor any disease which he can remember to have preceded this distortion of his countenance."

I have introduced this case, because the patient is at this time about the Middlesex Hospital, and can be seen as affording an instance of the effect of early paralysis in the seventh nerve.

On one point the following case is unsatisfactory, and therefore I am bound to give it:—

No. XXXVI.—*Partial Paralysis.*

"I take the liberty to transmit to you this case, as it is curious, and bears strongly on the physiological doctrines taught by Mr Charles Bell. If you are acquainted with him, or could obtain his opinion on it, I should feel much gratified, and greatly obliged to you. I am, Sir, your obedient servant, J. WEBSTER.

"*Ramsgate, 22d August.*

"A healthy male child, four months old, of a plethoric habit, was very restless during the night of the 11th of August; a dose of calomel and scammony had been given him the day before, and the mother supposed the restlessness was owing to this circumstance. She observed, however, that when he cried, his face was drawn forcibly to the left side. 12th. The aperient was repeated. 13th. On a careful examination there is nothing remarkable behind the ear or about the angle of the jaw, and the child allows the parts to be handled without shrinking. There is an evident puffiness above and below the zygoma. With the exception of the eye, the features on this side of the face of this lively laughing little fellow are quite without expression. When he laughs, the muscles of expression on the left side are thrown into considerable action, and when he cries (from the loss of all antagonising power), into the most disagreeable distortion, the right eye remaining wide open; the orbicularis palpebrarum, the corrugator supercilii, as well as the rest of the muscles on this side, remaining quite relaxed. The nose is drawn to the opposite side."

An account is given of the remedies and their effects, and the case then proceeds:—

"When he is made to wink, the left eye-lid moves with rapidity, whilst the right is quite stationary. The *occipito-frontalis* partakes also of paralysis; for when the child looks earnestly at any object, the eyebrow and skin of the forehead on the left side are drawn upwards, but on the right there is no corresponding motion. During sleep, the affected eye is only partly closed. The sense of feeling is alike on both sides of the face."

In writing to Mr Webster, I requested to know the condition of the eye-ball; the answer was not satisfactory.

"*October* 6. 1826.

"The right side continues relaxed and flabby, so as to give to the cheek the appearance of being larger than the other. The upper lip, on the affected side, overhangs the lower. If the child's attention is fixed, and the hands are suddenly clapped together before the face, the left eye-lids move rapidly, and the right upper eye-lid in part falls and recedes with a trembling motion, but the eye-ball is not moved. When the child sleeps, the aperture formed by the want of approximation of the lower eye-lid to the upper, crosses about the middle of the cornea; so that the direction of the eye-ball is that of a person looking downwards. On raising the eye-lid with the finger, so as not to disturb the child, and holding a strong light suddenly before him, the eye-ball is pulled downwards and outwards."

The letter concludes with an apology for not answering my letter sooner, "owing to the almost constant habit of the child nestling his face in the pillow, as it were to avoid the annoyance from light which the open eye is exposed to."

This is the only instance in which observation is at variance with my statement, that the eye-ball revolves upwards when the eye is threatened.

It is not necessary to carry the proofs further. In the following instance, extracted from a long and circumstantial case, the same effects are seen which result from the paralysis of the portio dura of the seventh nerve.

No. XXXVII.

"—— Masters, æt. 27.—His friends first remarked the distortion of the face. One eye was more disclosed than the other. The eye-lid of the left side did not move when the other was winking. This eye was notwithstanding clear, because the inferior part of it was covered by the lower eye-lid, whilst the upper part was moistened, during the act of winking, by revolving upwards under the upper eye-lid. When he was asked to blow his nose, the eye turned suddenly upwards under the eye-lid."

Petrus Forestus refers us to Rhazes for a description of the appearances in a case of paralysis of the side of the face. "Communia sunt signa juxta Rhas.: oris distortio, et quod unum oculum claudere non valeant: et si præcipias ut sufflent, flatus ab una parte exire videtur: faciei pars ægra est inflata, ob materiem replentem: ex latere effluit saliva vel sputum: torsio labiorum: superciliorum et unius oculi major occlusio. Signa tamen aliquando sunt occulta in principio vel contractionis vel resolutionis cum facie recta secundum situm sanum. Tunc ægrotanti imperabimus ut rideat, vel proferat literam O.: illico videbimus unam partem non posse moveri libere, imo trahi ab altera vel ad alteram deduci." The same author mentions that Velascus ordered his patients to carry a trumpet, which they were to sound frequently, to give the muscles strength. Some ancient writers recommended stitches in the cheeks. Avicenna advised the patient to stand before a mirror, and stretch the paralysed cheek with the finger.

No. XXXVIII.—*Paralysis of one side of the Face from an injury to the Head.*

William Coleman, æt. 37, was brought to the Middlesex Hospital, July 15. 1831, after having fallen from a ladder a height of ten feet into an area. He remained insensible for a short time; but had recovered from this condition when he came to the hospital. The right side of his head was severely bruised, and the right clavicle broken. In the evening visit, the house-surgeon had his attention drawn to a peculiar appearance of his right eye, and it was discovered that he did not wink with this eye. On examining the face more closely, it appeared that the whole of the muscles on the right side, which are controlled by the portio dura, were deprived of the power of motion. This led to the examination of the ear, and it was found that blood was flowing from the tube, and collecting in the concha; and also that he was deaf in this ear.

Upon observing the eye-lids more narrowly, it was perceived that they had a certain degree of motion, which led some of the gentlemen present to think that the branches which passed to them had escaped the injury. It was soon discovered, however, that the motion which was perceptible did not arise from the activity of the orbicularis, but from the movements of the eye-ball itself. When the patient was desired to close his eye, the eye-lids of the affected side nearly met; yet it could be seen that this motion resulted from the eye-ball revolving upwards; for as the prominent cornea was elevated, it pressed against the cartilaginous part of the upper eye-lid, thrust it forwards a little, and thus allowed the lid to fall downwards over the eye when the cornea got beyond the cartilaginous part. The patient was bled from the arm, and by leeches applied to the back of the ear, and he had a pill of calomel and antimony.

On the following day the blood was still oozing from the tube of the ear. His other symptoms, however, were not alarming. He complained of pain in the right eye, and there was some appearance of inflammation in it. In five days he was considered so well that he was allowed to leave the hospital. In the last report, dated August 20, more than a month from the time of the accident, it is stated that he continued to attend as an out-patient, without having any further symptoms of injury within the skull. The paralysis of the face was the same as at the first.

No. XXXIX.—*Paralysis of the Face from injury of the Temporal Bone.*

I received from Mr Perry, of Great James Street, a note, giving me the account of a child who fell from a swing, and had paralysis of the face. He was stunned, and bled from the right ear, and was deaf in that ear. Three weeks after, the child became paralytic on the right side of the face, with great distortion of the features. After a judicious antiphlogistic treatment, without effect, the paralysis disappeared under the influence of mercury.

This is not a solitary instance of paralysis of the face from injury of the temporal bone. It will be readily admitted, that whilst it was believed that the five branches of the fifth pair of nerves, distributed to the face, were muscular nerves, or nerves of voluntary motion, such a distortion as this could not have been attributed to its real cause, the injury of the portio dura in its course through the bone, but, on the contrary, to the injury of the brain itself. This case, therefore, affords another proof of the practical benefit to be derived from knowing the distinction in the functions of the fifth and the seventh nerves.

No. XL.

M. Montault has written a memoir lately on the Paralysis of the Face, in which he gives the details of his own case. He first of all discovered that he could not whistle to his dog; and then, on looking to his face in a glass, he perceived that his features were distorted. He was sensible only of a kind of *stupor* in the right side of his face. The affection was attributed by him to his having travelled in a coach where there was a broken window. Antiphlogistic remedies had no effect in diminishing the degree of distortion. Then he had recourse to the *electro puncture;* that is, he introduced five needles an inch deep into his cheek, and drew a current of galvanism along these, repeating this treatment seven times during eleven days, and continuing the current for twenty minutes each time. On the fourth day he could whistle to his dog, and on the last day he had quite recovered.

No. XLI.

R. B., now a patient of Mr Jephson of Leamington. A case of *portio dura,* well marked, in two letters: no wonder he is alarmed, for the effect is horrible on the face of a powerful muscular man. I promised him entire recovery; advised living low,—the gums to be slightly affected,—purgatives at stated intervals,—steaming the side of the head and neck, with embrocation. He entirely recovered.

No. XLII.

—— from Bury-St-Edmunds: Dr Probart.—Paralysis of the side of the face: (attacked in October, now January): found his face thus twisted in the morning, after exposure to cold, and pain in the ear from standing in the draught. Skin is quite sensible: every thing tastes sweet: he has taken a great deal of carbonate of iron. Our surgeon supposed syphilis to have been the cause.

I shall here add some familiar instances and cases, to show the importance of a knowledge of the nerves of the face in the investigation of disease.

No. XLIII.

J. Richardson, October 1820. On first looking at this man, there does not appear to be any thing unusual in the state of his face; but the moment he speaks or smiles, the mouth is drawn to the left side. When he laughs, the distortion is increased; and when he sneezes, the difference between the two sides is more extraordinary.

On holding ammonia to his nose, it was observed that he could not inhale freely with the right nostril; and on examining the state of the muscles, when the act of sneezing was excited by the ammonia snuffed up by the left nostril, it was found, that not only those of the right side of the nose and mouth, but also of the eye-lids, were passive, while all the muscles of the left side were in full action. When he blew, or attempted to whistle, the air escaped by the right angle of the mouth, the right buccinator not at all corresponding in action with the muscle of the left side, nor with that of the muscles of the chest and neck, by which the air was expelled. The sensibility of the paralysed cheek was equal to that of the other side, and he could close his jaws with equal force on both sides.

The early history of the case, according to the account given by the patient's friends, was this:

"He was seized with a severe pain under the ear, and in a short time became so delirious, and his face so distorted, that the people in whose house he lodged, supposing him to be mad from brain fever, carried him to the parish work-house. There he lay until his friends discovered him, and brought him into the hospital. It was then found, that the frenzy which had led the people of the lodging-house to suppose that he was mad, was only a high state of delirium, in consequence of a severe attack of cynanche parotidea. Indeed the inflammation had run so high, that an abscess formed and burst under the ear. When the swelling subsided the degree of paralysis was very observable."

The delirium and the paralysis of the face naturally led the medical gentlemen who first saw this patient to suppose that the symptoms were caused by an affection of the brain. Luckily, the treatment generally followed in cases of phrenitis was best adapted for the particular affection which had caused both the delirium and the paralysis. The portio dura being engaged in the inflammation under the ear was the true cause of the paralysis.

For the next case I am indebted to a physician in Worcester.

No. XLIV.

Worcester, July 25. 1823.

" Dear Sir,—My acquaintance with the nature of your late researches upon the functions of the nerves induces me to send you the following case:

" A young gentleman, aged fourteen, residing in the village of Kempsey, in this county, was observed by his family to have the expression of his countenance much altered. As long as the features were quiet, nothing unusual was observable in the countenance; but as soon as any passion was excited, the expression of the face was so different to what was natural to him, that his brothers and others of the family complained of his ' making faces at them.' He, in fact, smiled, laughed, or frowned, only upon the left side of his face, the muscles of the right side remaining inactive; and, as they passively yielded to the contraction of the muscles of the left side, the countenance, of course, was much distorted whenever these were called into action. He lost the power of whistling, and, for the same reason, of blowing, and was unable to close his right eye. The sensibility of the right side was as perfect as that of the left. He was quite unconscious of any change in himself, and was not at all aware of the distortion of his countenance when he smiled, &c. This affection did not occur suddenly, but seemed gradually to increase, and became so evident in the course of a week, as to induce the father of the young man to send for his apothecary, Mr Bick of Kempsey. When Mr B. saw him he found the symptoms as above stated; but, upon examining the right side of the face more minutely, he discovered a fulness immediately beneath the right ear, produced by a hard, fixed, and indolent tumour, lying between the ramus of the lower jaw and the mastoid process of the temporal bone.

" He ordered him some aperient medicine, and directed the tumour to be rubbed with camphorated oil. In a fortnight the tumour disappeared, and with it, gradually, the paralysis of the muscles of that side of the face. It is a fortnight since Mr Bick first saw him, and he has now recovered every power, excepting that of blowing or whistling. I saw him several times during the progress of his cure. It appears to me that the portio dura of the seventh pair was, in this case, injured by the pressure of an enlarged gland soon after its emergence from the stylo-mastoid foramen, and that, upon the removal of the pressure, its functions were restored.

"I remain, dear Sir, your obedient servant,

"Jonas Malden, M. D."

The danger to which the eye is exposed by paralysis of the portio dura, or by any operation on the face, in which its functions are not attended to, is well illustrated by the following case (Middlesex Hospital):—

No. XLV.

"This poor man, about nineteen years ago, was attacked by a severe pain, accompanied with discharge from the right ear. After a paroxysm severer than usual, he found, on getting up one morning, that the right side of his face was paralytic. His present condition, and the description which he gives of the progress of the symptoms, prove that the same results followed this paralysis, as in the instances already related. But what this poor fellow particularly laments, is, that since the day he was first attacked, he has not been able to close his right eye; and well he may regret this, for the constant exposure of the eye to the light and dust has been the cause of many attacks of inflammation, and consequently, of opacity of the cornea, so that the vision is now entirely lost. This, I fear, will often occur in similar cases; for I have observed that the eye has always become inflamed in those animals in which the portio dura has been cut. It is worthy of remark, that the inflammation has been more severe in the dog and in the ass than in the monkey. One great source of the increase of inflammation is the purulent secretion from the conjunctiva; this the monkey wiped away with his hand; but it lodged between the eye-lids of the dog and of the ass, so as to form an additional source of irritation."

The ultimate effects of the loss of power over the muscles of the face, in consequence of an affection of the portio dura, are shewn in the following extract:—

"A most remarkable appearance in the face of Garrity, is the wasting of all those muscles of the face which are subservient to respiration and expression. His cheek is so thin that, when he speaks, it flaps about as if it were only skin, and the corrugator supercilii and occipito-frontalis, which are principally muscles of expression, are so wasted, that we might, at first sight, suppose they had been removed by operation, and that now the bones were only covered by skin. There can be little doubt that the wasting of these muscles has been in consequence of their long inactivity; since the masseter and temporalis muscles of the same side, which retain their office, are not at all diminished in size, being as large as those of the opposite side."

A curious example of a contrary effect produced on the growth of the muscles of respiration and expression, by an injury of the portio dura, was afforded in an experiment made upon a young dog. After the nerve was cut, he was taught to snarl whenever a stick was held out to him; this being often repeated, the muscles of the side upon which the nerve was entire became very strong, while those on the paralysed side rather diminished than increased as the dog grew older. In a few months the one side of the face was much larger than the other. Every day we see similar results following palsy of the muscles of the limbs.

Many instances will now occur to my reader of cases where the paralysis of the face, consequent on a local affection of the portio dura, has been mistaken for an attack of apoplexy, and the patient treated accordingly. In one case the patient, of having undergone the discipline of bleeding, purging, and starving, and of having had his head shaved and blistered, was suddenly cured by the bursting of an abscess in his ear.

No. XLVI.

"In another gentleman, the disease commenced with a violent pain below the ear, and in a short time one side of his face became paralysed. For this paralytic affection he consulted many eminent men. The first plan of treatment was bleeding, blistering, and starving, the disease being supposed to have its origin in the brain; but as he got rather worse than better under this treatment, he was put upon a course of mercury, which was carried to such an extent that he lost several of his teeth. After he recovered from the bad effects of the mercury, he was recommended to attend only to the state of his digestive organs. But the blue pill had no effect upon the distortion. The last advice which this gentleman received was, to wear an issue in his neck; with this, however, he has not complied, as he feared it would, like some of the other remedies, have the effect of rendering him more uncomfortable."

A great many cases, somewhat similar, have been presented to me by my pupils; I will add only three other instances, two of which are from papers by Mr Shaw.

The first regards a patient who had suffered an attack of common apoplexy; it may be offered in example of that train of symptoms which is consequent on an affection of the original or symmetrical system of nerves, and as distinguishable from those which follow an affection of the superadded class. The second is of a man in whom both the portio dura and the fifth had been injured by a blow; and the third is of a patient in whom both these nerves seem to have been affected by a disease within the skull.

No. XLVII.

"J. Cooper.—This man's general appearance is completely that of an old paralytic, but the distortion of his face is more remarkable than usual, in consequence of the right, or paralysed side, being marked with a red blotch.

"The arm and leg of the same side are nearly powerless, his intellect is much impaired, and his memory gone. The history of his case was given very clearly by his wife. According to her account, her husband was for the first time, attacked with apoplexy about seven years ago; from this attack he gradually recovered, but at the end of twelve months he was a second time seized, and, since that period, he has had two distinct attacks every year; for the last two or three years he has been nearly in the same condition as at present.

"*State of the cheeks and mouth.*—When he is made to laugh, the right cheek rises in the same degree with the left; when he blows (he always bursts into a laugh when asked to whistle), the buccinator of the right cheek is in as much action as on the other side. When his nose is irritated by snuffing ammonia, the actions of the muscles, preparatory to sneezing, are equal on both sides of the face. The right cheek, and the right side of the mouth, fall lower than the left. When a piece of bread was put between the teeth and right cheek, the patient could not push it from its place, but was obliged to pick it out with his tongue. The saliva constantly flows from the right side of his mouth, and when drinking, part of the fluid escapes from the same side. The loss of the sensibility of the orbicularis oris was farther shewn by the inability to hold a pencil, or a tobacco-pipe, in the right side of his mouth.

"The comparative degree of sensibility in the two cheeks was next examined; when he was pricked on the right cheek with a needle he seemed perfectly insensible, even though I drew blood; but on giving the least prick to the left side he immediately started; the same difference in the degree of sensibility was observable in pulling a hair from each whisker. The sensibility of the right and left limb corresponded with that of the cheeks.

"On putting hartshorn to the right nostril he inhaled it as well as with the left, and immediately all the symptoms observable in a person about to sneeze were presented.* As the nose was turned up, and the alæ nasi of both sides were equally in action, this was a sufficient proof of the state of the paralysed side being here very different from the condition described in the foregoing cases. The power of the fifth over the nose was tried, by tickling the inside of the right nostril no effect was produced; but tickling the left nostril the symptoms of sneezing were again evident.

---

* The apparent sensibility of the nostril over which the fifth had lost its influence may be explained, by supposing that the fumes of the ammonia passed by the posterior nares to the other nostril, and thus caused sneezing.

"The motion of the eye was perfect.

"He could close the eye-lid of the paralysed side as well as the other; and when his nose was irritated by the hartshorn, or when he laughed, the orbicularis oculi and corrugator supercilii were in complete action, so that there was not here that heaviness in the expression of the upper part of the face, which is so remarkable in paralytic persons. Here, then, was proof that those actions of the eye-brows which we find to be deficient, when the portio dura is affected, are, in a case of common palsy, left entire; indeed, we may have daily opportunities, while walking in the streets, of observing that patients with palsy of one side of the body, have no difficulty in closing the eye-lids."

In the next case, both systems of nerves seem to have been affected.

No. XLVIII.

"Phipps, a bricklayer, on the 1st of September 1821, fell from a scaffold thirty feet high. His right clavicle was broken, his right loin and hip were much bruised, and he received a severe contusion on the head, the marks of which were particularly observable in a puffiness behind the right ear, and in bleeding from the same ear and from the nose.

"He was in a state of stupor when brought into the hospital, but from this he recovered in the course of the day. For the two or three first days he appeared to suffer only from the effects of *concussion*, never having any of those symptoms which are generally attributed to *compression*. On the fourth day, it was observed that the angle of the mouth was drawn rather to one side, and there was also a degree of inequality in the contraction of the pupils.

"On the sixth day it was remarked, that while he was asleep, the right eye was more than half open, while the left was closed.

"The notes of the case are very full up to the 24th of September, and shew that the patient had, during the interval, gone through the common series of symptoms which accompany that slight inflammation of the brain which is often the consequence of concussion.

"On the 1st of October, he was made an out-patient, his face being, at this time, very much distorted. The general appearance of his face was that of a man who has suffered paralysis from apoplexy; but it was further remarkable, that when he spoke or laughed, the distortion was much increased, the mouth being pulled more to the left side than I ever saw in any other patient.

"The following notes were taken at this time. There appears to be total paralysis of the muscles of the right side of the face. When he smiles or laughs they are passive, while those of the left are regularly in action. If he attempt to whistle, he cannot close his lips sufficiently;

when he blows, the right cheek is dilated, but passive like a distended bladder; he can smoke, by putting the pipe into the left side of his mouth; he throws the smoke out of the right side, but in doing this, the action is evidently confined to the muscles of the left cheek.

" The cheek and mouth hang down, as in the common case of hemiplegia—he cannot by a voluntary act move his cheeks; when a piece of bread is put between the cheek and teeth of the right side, he cannot push it out with the buccinator, but picks it out with his tongue. He cannot hold his pipe or a pencil with the right side of his lips. These may be considered as sufficient proofs of the total paralysis of the muscles of the face.

" The difference of the sensibility in the two cheeks was very distinct. When a hair of the right whisker was pulled, he was not conscious of pain; but he started immediately on pulling one from the left. When his cheeks were pricked with a needle, his expression was—' I feel you push against the right side, but in the left you prick me.' When he brought his jaws forcibly together, he said he was not conscious of striking his teeth on the right side, although he felt them most distinctly on the left. On examining the state of the nose, we found that it was impossible to excite the muscles of the right nostril to any action.

" Both the orbicularis oculi and corrugator supercilii were so completely paralytic, that he could neither close his eye, nor knit his brow on the right side.

" On examining how far the branch of the fifth which passes to the eye and eye-lids was affected, we found that the symptoms did not exactly correspond with those observed in the parts regulated by the other divisions of the fifth pair, for when a hair was pulled from each temple, or from the eye-brows, the pain felt in the two sides was nearly the same. Neither the temporalis nor masseter muscles of this side were paralysed. The motions of the eye-ball were so far perfect, that he could follow an object carried before him, but he could not direct both eyes truly, he saw double. The contraction and dilatation of the pupil of the right eye were much the same as in the other eye.

" He can put out the tongue and move it in every direction with the greatest ease: the motions are all apparently correct and natural; he can throw a morsel from one side of the mouth to the other, and towards the throat, and he can pick it out from between his cheek and teeth.

" These observations led us to conclude, that not only the motor linguæ, or ninth nerve, but also the glosso-pharyngæal, were perfect."

This case differs from the common examples of partial paralysis of the face, not only in there being evident marks of paralysis while the muscles of the face are at rest, but in the sensibility of the skin of the same side being in a great measure destroyed. It differs also from the case of hemiplegia.

The first difference which we observe in it, from the case of common hemiplegia, is, that the paralysis is confined to the face. Secondly, that the paralysis is on the same side with that on which the head is injured. Thirdly, that the palsy is more evident, when the patient is made to sneeze or laugh. From these circumstances, we may conclude that there was here an injury of the skull affecting both the fifth and the seventh nerve.

No. XLIX.

James Gulland, ætat. 26.—Was admitted into the Middlesex Hospital, April 15. 1823. His mouth and left cheek are twisted towards the right side: the whole surface of the left side of his face is insensible: he has lost the power of moving the eye of that side, and the eye has lately become inflamed; he complains of a deep pain in the temple of the same side.

His trade has been so profitable as to enable him to live in a most dissipated manner during the last five years. He has frequently strolled about the streets at night in a state of drunkenness; he has not for three weeks thrown off his clothes, and has been seldom in bed. He has been twice affected with syphilis: he was confined by his first attack for eighteen months, during which time he was under the influence of mercury. After regaining his health, he frequently experienced a pricking pain in his left eye and temple, so severe as to prevent his reading, especially by candle-light. About twelve months ago he was knocked down: he fell on the back of his head, and wounded the occipital artery; he thinks that he has never been quite well since that time. On the 13th of October last year one of his comrades observed to him that his mouth was drawn to one side; this induced him for the first time to observe in a looking-glass the condition of his face. He tried to spit, and observed that his saliva, instead of passing through the centre, was squirted out of the right corner of his mouth, which was contracted. His lips were in other respects perfectly natural, being possessed of sensibility and the power of motion. He could then likewise close the eye-lids of the left eye, but to do this he required to shut the other eye also.

On the following morning he was conscious of a peculiar numbness above the left eye. This numbness gradually spread over the left cheek, and at the same time affected the external and internal surfaces of almost all that side of his head. He lost the sense of taste on the left side of his tongue, and in little more than a fortnight he became deaf in the left ear. Now he complains principally of the inflamed condition of the left eye (which commenced about ten days ago), and of the pain in his left temple.

The above circumstances he himself could relate distinctly. The following is an account of his condition, April 20.

The left side of his face is drawn towards the right, and is slightly œdematous. The left nostril is collapsed, and does not expand during breathing. The mouth is distorted towards the right side. When he speaks, the two sides of his face are distinctly marked by a line of division; the action of the muscles of the mouth and nostrils, on the right side, being quite distinct, while the muscles on the left are motionless. He has lost all power over the left eye-lids; until lately, he could elevate his upper eye-lid, although, since the time of his first attack, he has always experienced a certain difficulty in closing it. At present the eye-lid hangs down flaccid and shut; he is unable to press the eye-lids together.

The sensibility to touch is gone on the greater part of the left side of his head and face, and this insensibility extends to the vertex of the head. The surfaces of the conjunctiva and eye-lids are also completely insensible; the eye is inflamed and ulcerated; the left side of the nose, the cheek, the upper and lower lips, are all equally insensible; but he is sensible when touched upon the left side, below the under jaw, and even over the lower jaw itself, as high as the inferior part of the lower lip. The external ear, and likewise the back part of his head, nearly as high up as the vertex, retain their natural sensibility.

The internal surfaces of the left nostril, and of the mouth and gums on the same side, are insensible to touch; and he has neither the sense of taste nor common feeling in this side of the tongue. In consequence of this, portions of food have sometimes lodged within the left side of his mouth, without his being aware of their presence, until they became actually putrid.

The power of moving his tongue is quite perfect: if at rest, it lies in its natural position within the mouth; nor is it dragged towards either side when he is told to move it. Being tickled with a probe on the left side of the root of his tongue, the sensation of nausea and the effort of retching are produced as on the opposite side. He can open and close his jaws; yet it can be observed, when he is made to clench his teeth, or to bite forcibly, that the masseter and temporal muscles of the right side are hard, rigid, and strongly in action, while the same muscles belonging to the opposite side are totally different in that respect, for they feel soft and flaccid.

With regard to his left eye, it has been already noted, that it is deprived of common sensibility, and that he has no power of shutting or raising his eye-lid. Besides these symptoms, he has no command over the eye-ball: his eye remains fixed and motionless, and directed straight forward. There is no motion in the pupil when a light is presented to the eye. He has the power of vision, although he sees dimly; this is, probably, on account of the eye being inflamed, and the cornea ulcerated and opaque. When both his eyes are closed, he is sensible of a red light in the left eye, while nothing is visible in the right one.*

---

* See remark on this, in the first paper on the Motions of the Eye.

He was questioned as to the period when he observed that he had ost the power of directing the left eye to objects, but he was unable to inform us, because he had always imagined that the one eye was as much in motion as the other.

August, 1824.—Several of the symptoms of paralysis, both of the portio dura and of the fifth, are become more indistinct; he has regained a little power over the motions of the eye-lids, and of some of the muscles of the face, and the surfaces are endowed with a slight degree of sensibility.

In this case we may observe, that the symptoms shew the affection to be limited to the seventh and fifth nerves of the left side, and they best correspond with the supposition, that a disease of the bone, or membranes, has affected these nerves in their course, and is gradually extending forward to the nerves of the orbit.

No. L.—*Affection of the Nerves of the Face.*

A gentleman, twenty-five years of age, consulted me, on the recommendation of Dr Cheyne, of Dublin. He begins the history of his complaint so far back as 1825, when he had pains in his head, which came on for two or three hours in the day, and which he attributed to bathing in the river. These pains affected the left temple and side of the nose. They increased insensibly, but were not constant; on the contrary, during his travels they changed so as to make him attribute the variations to the effect of some peculiarity in his place of residence. Thus he left Paris on the 1st of October of that year, and, "strange to say, the pain which afflicted me so severely and constantly, both night and day, suddenly left me before I was twelve miles from Paris, and did not return during that month whilst I remained in London." But when he went home to Ireland, his old pain attacked him with greater violence than before. There were some further irregularities in these attacks of pain. Thus, on one occasion, on taking wine, the pain suddenly left him: on another, while sitting at dinner, the pain became suddenly so severe, as to require persons to hold him in the agony of his sufferings.

In the summer of the second year, having gone to the coast for sea-bathing, the pains increased with a new train of symptoms; his sight frequently became dim for a short time, and things appeared to turn topsy-turvy. Now for the first time he took medical advice: and his surgeon, after acting upon the belief that this was nothing more than the effect of disordered bowels, advised him to go to Dublin, for his jaws became affected. He found, one morning, that they were locked, and says he was obliged to open his mouth with his hands. This spasm gradually went off in the course of the day, and the pain subsided. Next morning he found a great stiffness about his mouth, and felt as if his lips were swoln. "But," he adds, "this was but the commencement of that stiffness which has been my complaint ever since."

In Dublin he had leeches applied, his head was shaved and blistered with tartar-emetic ointment; blisters were applied behind the ears, and he took strong doses of calomel. The medical gentlemen there made him walk, to observe whether the motion of his limbs was perfect. At this time he thinks his memory must have been impaired, for although he fell and hurt his arm, yet he so far forgot the circumstance, that his mother had occasion to remind him of it.

He never had any sore throat, or suppuration in the ear, and never felt any paralytic weakness of the side.

His present condition is this. The expression is almost entirely in the right side of his face. The eye-brow on the left side cannot be knit. The forehead on that side is smooth. The eye-lids do not perfectly close in winking. He can draw up the side of his mouth with the zygomaticus, yet it is with an effort, and less perfectly than on the opposite side. He is not altogether without feeling in this left side of his face; but there is very considerable numbness, and he experiences a scalding sensation in the edge of the tongue, all along to the tip, on the left side. He has perfect motion in the tongue. Its surface is deeply coated. There are no swellings about the ear or jaws.

This gentleman was ordered small doses of salts with sarsaparilla, an application of steam to his ear and side of his neck, and a seton under the occiput: the opinion being, that although suspicion might attach to the state of the bowels, yet an inflammatory attack had certainly injured the roots both of the fifth and seventh nerves. A very careful and regulated diet was enjoined, and hopes were held out, that with these precautions an amelioration would take place in the expression of the countenance.

I shall give here the outline of one or two cases from foreign authors.

No. LI.

"A phthisical patient* had a suppurating tumour on the parotid gland, which exposed the mastoid portion of the digastric muscle. Paralysis of the face came on gradually, and at length the following symptoms presented.

"The eye-ball was perfectly under the control of its muscles. The upper eye-lid could be moved. The lower eye-lid was relaxed and everted. The eye was constantly weeping.

"The nose was dragged to the left side; the nostril of this side remained narrow, while that of the other was dilated by the action of its muscles. The mouth was dragged to the left side. The tongue was perfectly free in its movements.

---

* See Descot sur les Affections Locales des Nerfs, p. 318. 1825.—M. Descot published before the translation of these papers into French by M. Genest.

"When she laughed or spoke, the expression was most strange. On the right side, her face was as that of a dead person, while the left was highly excited. In speaking, we could see the buccinator puffed out and relaxed alternately, like the leather of a pair of bellows.

"Whilst sleeping, the upper eye-lid covered the pupil, while the lower eye-lid was depressed and everted. Some hairs on her upper lip were pulled, which awoke her, and made her complain of being teased.

"At her death, respiration was convulsive. The eye-balls rolled in their sockets: the muscles of the left side of her face contracted with force, while those of the right side remained still; and the mouth and nostrils being convulsively pulled towards the left side, a frightful expression of countenance was produced."

There is a minute account of the dissection given; but it is sufficient to say, that a portion of the seventh nerve, corresponding with the breadth of the ulcer, was destroyed: the two ends of the nerve which were thus separated appeared as if teased out.

M. Descot, perfectly candid as to the source from which he takes these views, leaves me under obligation to him.

He remarks, that it is inexplicable how she continued to possess the motion of the upper eye-lid. I would offer this observation. M. Descot having seen two extremities of the divided nerve, it must have been a branch or portion only which was here destroyed. For if the nerve had been destroyed as it makes its exit from the stylo-mastoid foramen, its course before it splits being very short, he might have seen one extremity coming out from the bone: he could not have seen the corresponding end of the nerve, but must have detected many branches. No doubt, therefore, the superior division of the *pes anserinus* had escaped the effect of the inflammation and ulceration. The branches of the portio dura which go along the temple to the upper eye-lid had remained entire: hence the action of the upper eye-lid was perfect, whilst the lower eye-lid, and all the rest of the face, were paralysed. I have stated that, from an abscess before the ear, I have seen the eye-brow fixed, while all the rest of the face continued in possession of its natural motions: no doubt, because the superior branches only of the diverging nerve were engaged in the disease.

In the same author there is an instance given of destruction of the portio dura, by suppuration in the temporal bone, which was attended with paralysis of the face, and difficulty of swallowing. The latter symptom took place in the case referred to at p. 306. under Dr Gregory's care. See the System of Anatomy, vol. ii. p. 508.

No. LII.

I select the following quotation from Beclard's notes upon the partial Paralysis of the Face. In these he makes reference to my discoveries, as explained by Mr Shaw in his paper in the Med. Chir. Trans. 1822. "Il y a quelque mois qu'en enlevant une tumeur carcinomateuse de la région parotidienne droite d'une femme, le tronc du nerf facial fut excisé. Le côté droit de la face est resté paralysé; mais la paralysie ne devint apparente que dans les mouvemens de la respiration et de la parole: dans tout autre cas elle est à peine apercevable." Descot sur les Affections Locales des Nerfs, p. 313. I would just observe upon this, that many years ago I saw my brother perform this operation with similar effects. At my entreaty, during the operation, instead of cutting out the root of the diseased parotid gland, which would have been attended with a division of the carotid artery, he was induced to apply a ligature around the root of the tumour, which of course included the portio dura. If the branches of the fifth pair were repeatedly cut for the tic douloureux, and the portio dura cut across or encircled with a ligature, without a conception arising in the operator's mind of the functions of these nerves, it brings us forcibly to the conclusion, that it is through the knowledge of the anatomy, and not by what is termed experience, that we are to obtain correct notions of the functions of parts, and more especially of the nerves.

No. LIII.—*Syphilis. Paralysie du Nerf facial.—Traitement spécifique. Séton; Vésicatoires.—Guérison.*

The singularity of the following case is, that without any affection attributable to the condition of the brain, and without loss of sensibility to the face, or loss of motion in the tongue, the functions of the portio dura of the seventh nerve were temporarily interrupted. But the condition of this girl was attended with this remarkable consequence, that she retained her good humour, and sometimes laughed heartily, as it is happily expressed by the narrator, as if behind a mask,—her face being quite immoveable and grave, whilst the emotion and sound of laughter prevailed.

Salle Saint-Jean, No. 12. Une jeune fille, âgée de 16 ans, grande, bien développée, réglée depuis plus de dixhuit mois, d'une bonne santé habituelle, contracta une blennorrhagie vaginale et urétrale au commencement de Novembre 1828. Elle ne fit aucun traitement et vint à Paris six semaines après, c'est-à-dire vers le 20 Décembre. Elle portait à cette époque une tumeur peu volumineuse sur la région frontale gauche. Le surlendemain de son arrivée, pendant la nuit, sans douleur préalable, sans cause accidentelle, elle éprouva un engourdissement dans la joue gauche,

toute la face de ce côté était raide et insensible, et le matin elle s'aperçut que la bouche était très-fortement déviée à droit. La langue était un peu raide et la parole embarrassée. Il n'y avait du reste aucun autre symptôme.

Un médecin appelé de suite prescrit une saignée de bras; on en pratique une seconde le soir du même jour; des sangsues sont appliquées à l'anus le lendemain, et le tout sans succès. Deux jours après la malade est conduite à l'Hôtel-Dieu.

L'écoulement blennorrhagique ex l'exostose de la bosse frontale gauche sont constatés, la malade n'éprouve du reste aucun symptôme cérébral ou gastrique. La langue est mobile, sans déviation, et on voit que la difficulté de parler résulte de l'immobilité de la joue et des lèvres. Deux jours de suite on administre l'émétique en lavage; le troisième jour on fait une saignée de bras, il n'en résulte aucun changement. On commence alors le traitement anti-syphilitique de M. Dupuytren, qui consiste en pilules composées d'un huitième de grain de deuto-chlorure de mercure, d'un demi-grain d'opium et de deux grains d'extrait de gayac. On donne trois de ces pilules par jour; la malade boit un ou deux pots de décoction de salsepareille avec addition de 4 à 6 onces de sirop sudorifique.

Huit jours après l'apparition de la paralysie à gauche, le même symptôme se manifesta subitement à droite, et la malade en se réveillant n'offrait plus de déviation de la face, mais bien un relâchement complet, une immobilité absolue de tous les traits du visage. Les paupières ne se fermaient qu'à moitié, et les larmes coulaient sur les joues; les lèvres restaient béantes, agités comme deux drapeux par l'air expiré. La langue n'était pas affectée. Cette paralysie de la face n'avait lieu que pour le mouvement, car la peau et les muqueuses n'avaient rien perdu de leur sensibilité. La malade ne souffrait pas, et sa physionomie habituellement très expressive, conservait alors un charactère sérieux qui contrastait singulièrement avec sa disposition d'esprit. On l'entendait rire aux éclats, mais elle riait comme derrière un masque. Cet état lui causait beaucoup de chagrin.

Le traitement fut continué avec la plus grande régularité. En même temps on appliqua un vésicatoire sur la joue gauche, très près de l'oreille, on en mit successivement plusieurs autres sur la même région du côté opposé, puis derrière les oreilles; enfin on plaça un large séton à la nuque. Il causa beaucoup de douleurs, et ce ne fut qu'au bout d'un mois que la suppuration fût bien établie, que l'on put s'apercevoir de ses bons effets. Au bout de deux mois de traitement, la mobilité des joues reparut peu-à-peu, la malade cessa de dormir la bouche ouverte, les paupières se rapprochèrent de plus en plus et le larmoiement diminua. Il est à remarquer que les sens n'ont jamais été affectés; l'odorat, le goût ont conservé leur finesse. La sensibilité de la peau n'a éprouvé aucun changement.

La santé de cette jeune fille n'a offert aucune altération, son appétit était excellent, cependant elle craignait de manger dans les commencemens de sa maladie parce que les joues immobiles laissaient les alimens s'amasser entre les arcades dentaires et leur face interne la bouche s'emplissait, sans pouvoir se vider, par la formation et la déglutition du bol alimentaire. Plus tard elle s'habitua à cet état, sa langue, ses doigts et divers instrumens servaient à suppléer l'action des muscles buccinateurs et labiaux.

Ainsi que nous l'avons dit, l'amélioration a été lente, et ce n'est que peu-à-peu que les muscles de la face ont récupéré la faculté de concourir aux phénomènes de la respiration, et de peindre les émotions intérieures. Nous avons vu la malade éternuer sans présenter cette expression de la face, si remarquable dans cette circonstance; elle baillait en abaissant la mâchoire, mais les lèvres et tout le visage, n'indiquaient en aucune manière la sensation qui accompagne l'accomplissement de cet acte. Nul doute que si une circonstance quelconque eû occasionné de la dyspnée, les ailes du nez ne fussent restées immobiles au lieu de se relever et de concourir à cette expression d'angoisse qu'on observe si souvent chez les asthmatiques.

Après quatre mois de séjour à l'Hôtel-Dieu, cette jeune fille est sortie dans l'état suivant. L'exostose de la bosse frontale gauche a disparu, la blennorrhagie est guérie, et la santé générale est excellente. La figure ronde et fraiche exprime avec vivacité toutes les sensations physiques et morales; le rire seul est un peu froid, c'est-à-dire que le mouvement des lèvres ne semble pas correspondre à la rapidité et à l'ètendue des mouvemens du diaphragme et des côtes. La mastication est facile et les alimens sont bien réunis en bol. Les paupières se rapprochent complètement, mais il faut un léger effort, et souvent les larmes coulent sur la joue. Le seton est maintenu en place, et tout porte à croire que dans quelques mois il ne restera plus à la malade que le souvenir de cette affection singulière.

Si les belles expériences de Charles Bell sur les usages des nerfs encéphaliques avaient besoin d'être confirmées par des faits cliniques, cette observation serait plus propre qu'aucune autre à démontrer la justesse de son opinion sur les fonctions du nerf facial. On a vu survenir dans cette maladie tous les accidens qui résultent, chez les animaux, de la section de ce nerf à sa sortie du trou stiloidien. Il est probable que chez elle une exostose légère a comprimé les nerfs à leur sortie du crâne. L'efficacité du traitement anti-syphilitique n'est pas contestable dans ce cas. Les topiques irritans et révulsifs ont achevé la cure; ils étaient indispensables, car souvent après la destruction de la cause qui occasionne une paralysie, ce symtôme a encore besoin d'être combattu par des stimulans locaux.

P. M. *d.-m. P.*

No. LIV.—*Consequences of Cutting the Portio Dura in operation.*

"Dear Sir,—The case to which I alluded in my lecture this morning, as illustrative of your views, was that of a young lady from Scotland, who had a tumour deep seated behind the angle of the jaw. It was partially, and but partially, removed by an eminent surgeon in this town. In performing the operation, the respiratory nerve of the face appears to have been divided, the mouth being drawn to the opposite side to a much greater extent than is common in hemiplegia connected with apoplexy; the ala of the nostril and the whole side of the face participating in the paralytic affection. But the most distressing part of the evil consists in the loss of power over the eye-lids, in consequence of which they cannot be brought together, so that the eye is never properly covered. The tears escape upon the cheek, and there are frequently slight attacks of ophthalmia; or perhaps it would be more correct to say, that some degree of inflammation is always present. The circumstance occurred several years ago, and no improvement whatever has taken place. Respectfully and very truly yours,

R. Macleod.

January 17*th*."

No. LV.—*Case of Paralysis of the Face, in M. le Professeur Roux of Paris; communicated by himself to M. Descot.*

"I have for many years been subject to rheumatism, which has most commonly been seated in the loins. In the month of October 1821, I was attacked with paralysis of the right side of my face. I am not aware of having been exposed to any influence which was likely to excite rheumatic disposition in the muscles or nerves of the face; but it appears from the circumstance of the muscles being paralysed that some irritation has existed, probably a rheumatic irritation of the facial nerve. When the paralysis was complete, I began to feel pain in the temple, and there was œdematous swelling in the part. During the course of this complaint I have experienced two circumstances which may lead to the detection of the facial nerve becoming affected. 1. The membrane of the tympanum was painfully sensible even to slight noises. 2. The sense of taste was affected in the right side of the tongue, so that every thing tasted metallic. This last symptom has even been a precursor of the complaint, being observed twenty-four hours before the occurrence of paralysis. In other respects, little pain was experienced, even in the trunk or the branches of the facial nerve. There has been no diminution of the sensibility in the skin of the face. The paralysis of the occipito frontalis muscle, of the orbicularis palpebrarum, and of all the muscles of the lips, on the right side, was complete. I have been like a patient who has hemiplegia, pronouncing words imperfectly, unable to blow with my mouth, laughing only on one side, feeling an inconvenience in eating, from want of action in the buccinator, deprived of the power to close my eyelids," &c.

This complaint ceased gradually as it began, yet rather more slowly.

This is the sort of case which is apt to throw the pathologist into difficulty, and therefore we shall give it some consideration.

The sensibility evinced in the ear indicates an inflammation in the course of the portio dura, or at least an affection commencing there, and by influencing the trunk of the nerve, producing the paralysis of the face. I have stated why the respiratory nerve of the face, and the sensitive nerve, take different routes to their destination; but it is not to be supposed that the sensibilities and motions of the face are in any degree more independent of each other than those of the arm, or any other part of the body. Accordingly, irritation and pain produce in the face what irritation and pain may in any other part of the body. I would only suggest to the observer, that he should distinguish those motions which are expressive of pain from those which are spasmodic and incontrollable.* This will be especially necessary in studying the disease called tic douloureux.

No. LVI.—*Case of Trismus, conjoined with Paralysis of the Face.*

Thomas Jones, æt. 29, a groom, was admitted into the Middlesex Hospital under Mr Bell's care, October 10th. He complained of a painful stiffness in his jaws, and the muscles of one side of his face were paralysed. He stated that, on the last day of September, while dressing his horse, it struck him with the fore-foot upon the right side of his head, and knocked him down. He remained insensible for some time. When he returned to consciousness he felt weak, and a little sick. There was a wound, as if made by the heel of the shoe, just over the external angular process of the frontal bone. Nothing, however, was done for him, and he lived as usual. It was mentioned by his master that he was much given to drinking, and that at one time his head and hand trembled from its effect like an old person's. On the fourth day after the accident he first perceived that his face was twisted to one side; he then had also some difficulty in speaking and in swallowing. It was not till the 6th October that he consulted a medical man, who recommended him to go to the hospital.

The face is twisted to the left side, as in the cases of partial paralysis from injury to the portio dura of the seventh pair of nerves; and this distortion of the face is most observable when he speaks. Upon being asked to close his eyes, the left is shut, but the eye-lids of the right side are very imperfectly closed, and in the attempt the cornea is turned up. The feeling on the right side of the face is as perfect as on the left. It cannot be perceived how far the motion of the tongue is impeded, as he cannot open his mouth freely: he is apt to bite both his tongue and cheek while eating. The wound on the side of the orbit resembles a mere scratch, nearly healed. There was no bleeding from the ear after the accident, and he hears perfectly with both ears. There is a fulness and rigidity about the masseter muscle on the right side, and Mr Bell thought there was a preternatural swelling before the right ear.

---

* We find *trismus* and *tic* as a title; diseases quite distinct classed together.

Hirudines, xii. ante aurem.
Pil. Colocynth. cum Calomel. gr. x. statim, et mane haustus purgans.
Lotio Plumbi Acet. cum Opio ad partem dolentem.

11th Oct.—The house-surgeon was called in the morning to this patient, as it was reported he was seized with a fit. He found him struggling like one who is suffocating. He seemed to labour from a difficulty of expectoration; his jaws were firmly clenched; his face was livid; the muscles on the right side were relaxed and drawn to the left side; those of the neck were rigid and in strong action. It required the power of two men to restrain him in bed. Two drachms of the tincture of opium were administered in small quantities between his teeth, after which the fit left him. He was quite sensible during it, and called it an attack of the cramp. To-day his jaws are more firmly closed. He complains of a pain at the back of his neck, as if something were dragging or pinching him there. His bowels have been opened. Pulse 110, and firm.

Cucurb. cruent. occipiti.
Hydrarg. Submur. gr. x.
Tinctura Opii, ʒss. 3tiis horis.

12th Oct.—The patient to-day was visited by Drs Latham, Watson, and Hawkins. The teeth are more closed. The attempt to swallow brings on violent convulsions in his throat and chest; he refuses to take any drink, and he has not taken his medicines, from the fear of bringing on these attacks. The suffering of which he complains most is from the phlegm in his throat, which makes him cough, and he throws out his saliva as in hydrophobia. During the paroxysms he starts up in bed; and we find him now sitting on the side of it, unwilling to lie down, as he is afraid of a recurrence of the fits.

Capiat Hydrarg. Submur. gr. x.
Enema Opii.

Cucurb. cruent. nuchæ ad ℥x.
Descendat in baln. calid.
Cataplasma cum Lotione Plumb. Acet. cum Opio ad vulnus.
℞ Extract. Tabaci. Unguent. Hydrarg. part. æqual. fiat Unguentum.
This ointment is to be rubbed upon the neck and jaws.

13th.—Yesterday he was put into the warm-bath, which was followed by a copious perspiration, and he expressed himself relieved by it. The fits attacked him four or five times during the day, and they continued about five minutes each time. He was unable to speak during them. His head was thrown back and his chin was tilted up, but not so much as to be called opisthotonos. He has never complained of spasms in his epigastrium. He possessed a perfect command over his arms, legs, and head; but he had convulsive twitchings as he lay in bed. About seven in the evening his jaw began to be relaxed, but this was accompanied with evident symptoms of approaching dissolution. He sunk gradually, after having had severe fits, and died this morning at ten o'clock.

Examination, twenty-four hours after death.—The features were distorted, as during life. The right eye was wide open, while the left was shut. The cicatrix on the side of the head was examined, but nothing appeared to indicate any morbid condition of the parts in its neighbourhood; the skin only seemed to have been divided. The fibres of the orbicularis palpebrarum, which were under the cicatrix, seemed natural, and the bone was not injured. The parotid gland was in a healthy condition. When the branches of the supra orbital nerve and those of the portio dura were minutely traced towards the wound, nothing remarkable could be observed in them. There was a small gland, not bigger than a field bean, imbedded in the substance of the parotid gland, and lying in contact with the portio dura. When this was cut into, it was found to contain a little purulent matter, but the nerve was not adherent to it, and did not seem altered in its structure. When the brain was examined, the tunica arachnoidea was found slightly opaque, and the veins were more turgid with blood than natural. There was also some serum in the ventricles, but in other respects, on a close examination of this organ, and of the nerves coming from it, the appearances were perfectly healthy. The roots of the fifth pair of nerves, and the course of the portio dura through the temporal bone, on the right side, were carefully examined, without detecting any alteration from their natural structure. The spinal marrow seemed healthy. The nerves of the sympathetic system (in the abdomen and the chest) were examined, without discovering any thing preternatural. The viscera, both of the thorax and abdomen, were in a healthy state, and the lungs were not more gorged with blood than is common. The glandulæ truncatæ at the root of the tongue were enlarged, but there was no redness marking inflammation either in the fauces, larynx, or œsophagus.

Mr Bell, in his observations on this case, first remarked its resemblance to some cases of partial paralysis of the face, in which he had been consulted during the present season. He admitted that the incapacity of closing the eye, and the total loss of motion of the lips and cheek on one side, deceived him when he first saw this patient in the waiting-room. The anomaly of the case was, that on the side where the hurt had been received, the exterior muscles of the face, all those influenced by the portio dura, were in a state of paralysis; whilst the muscles of the jaws, supplied by the fifth pair, were in a state of tetanic spasm. He related a case of paralysis of the muscles of the face on one side, produced by a blow upon the head; but he added, that, in the present case, on looking retrospectively, there was no reason to suppose the symptoms referable to an injury of the brain, much less to an injury of the nerve passing through the bone; it was, he conceived, a case of trismus, arising from the slight bruise of the integuments of the temple operating upon a constitution morbidly predisposed. The only peculiarity was the partial paralysis: he could not charge his memory at that time with another case where this symptom was combined with trismus. A. S.

No. LVII.—*Disease of the Portio Dura extending to the Fifth.*

" *Stephen's Green, May* 7. 1827.

" My Dear Sir,—It is high time for me to thank you for your kindness in sending me your last publication on the Nerves, which clearly illustrates your notions of the functions of the various parts of this system, and which must directly lead to a new and useful line of treating some of the diseases of that system.

" Permit me to trouble you with the outlines of a case at present under my care, which present a combination of symptoms not often met with.

" Mr S———, about eighteen months ago, suffered severely from pain in the occiput and back of the neck. This suddenly and unaccountably left him, and again returned in August last. About the middle of October, he was affected with paralysis of the left side of the face, attended with a slight dilatation of the pupil of the left eye, an inability to close the eye-lids, and, agreeably to your account of such cases, with the turning up of the eye-ball when he attempts to close the lids. On the attack of paralysis, the pain of the occiput and neck ceased, but returned again with great severity, and without any assignable cause, early in January. By the exhibition of calomel, to the extent of nine grains a-day, the pain was removed, and, with it, giddiness, great weakness of the limbs, nausea, and loss of appetite; which symptoms had attended the recurrence of the pain. This attack, however, left after it a new and distressing symptom.

"Mr S. now complained of great coldness in the affected side of the face, of a total want of feeling in this part, of want of taste in the left side of the tongue, and of such imperfection in chewing, that he repeatedly pinched his cheek between the molares teeth when he attempted to chew at this side.

"Mr S., about four weeks ago, had another attack, equally severe with either of the former, and attended with extreme weakness of the limbs, with more of giddiness, of vomiting, and more complete loss of appetite. In this attack he lost flesh most rapidly. Again the use of calomel, with a small caustic issue to the occiput, has restored him to tolerably good health; the insensibility of the face and tongue remaining as it had been after the second attack of pain. It may not be amiss to add, that Mr S. had been repeatedly subject to a purulent discharge from the left ear. Should any remarkable change take place in this case, I shall be happy to communicate it to you, if you think it worthy of your attention.

"Believe me, dear Sir, yours very sincerely,

"A. Colles."

LVIII.—*Dissection which shews the Portio Dura compressed by a Diseased Gland.*

"Few opportunities have as yet occurred of ascertaining the condition of the nerve in those interesting cases of local paralysis which have been so beautifully illustrated by Mr Charles Bell and his lamented friend the late Mr John Shaw. It is probable that there is either an inflammatory action in the nerve itself or its coverings; or that the nerve is affected by disease of some of the parts through which it passes. The only case in which I have had an opportunity of examining the parts, since I was acquainted with the discoveries of Mr Bell, was lately, in a woman about forty years of age, who died of organic disease of the stomach. About a fortnight before her death, she was seized with twisting of the mouth and paralysis of the orbicularis of the left eye. She had afterwards considerable indistinctness of speech, and before her death there was inflammation of the left eye, with an evident tendency to sloughing of the cornea. A small hard tumour was felt under the ear, deeply seated betwixt the angle of the jaw and the mastoid process. On dissection no disease could be discovered in the brain. The tumour under the ear was found to be of the size of a small bean, very firm, of an ash colour, and, when cut across, it discharged thin puriform sanious fluid from minute cells in its substance. It lay directly above the facial branch of the portio dura, and there was considerable appearance of inflammation in the cellular membrane surrounding the nerve; but I could not discover any deviation from the healthy structure in the nerve itself. I thought it was diminished in size at the place where the tumour lay over it; but in this I might be mistaken."—*Pathological and Practical*

Researches on the Diseases of the Brain and Spinal Cord, by Dr Abercrombie, p. 415.

No. LIX.

"*Stamford, 10th July* 1829.

"Sir,—Mr ———, who will deliver this to you, became a month since affected with paralysis of the muscles of the left side of the face. This affection had been preceded by pain near the foramen stylo-mastoideum and parotid gland, but not so severe as to excite much attention from the patient, till questioned on the subject. That the mischief was in the course of the nerve, and not at its origin, was indicated by the absence of all symptoms that might be referred to the brain, and by the portio mollis not being affected. The treatment, therefore, was directed by the principles laid down by Mr Shaw, founded on your discovery respecting the use of the nerves, and the truth of which these cases so strikingly illustrate. The muscles have lost their power, but retain the sense of feeling, because that is transmitted by another nerve.

"I have applied blisters and leeches behind the ear, and over the parotid gland, attention being paid to the state of the primæ viæ; the parts affected have been well rubbed with a stimulating embrocation. I was about to apply the cupping glasses behind the ear, and to have recourse again to the leeches and blisters, in concurrence with the opinion of Mr Cooper, of this place. The patient being called to town, I am desirous that he should avail himself of the opportunity of obtaining your opinion, which he also is anxious to do.

"I am, Sir, your obedient servant,

"Edw. Hatfield.

"To Charles Bell, Esq."

"*Soho Square, 14th July.*

"Dear Sir,—I have made an accurate examination of your patient's symptoms, and I think your diagnosis correct. The face is twisted to the left side. The right nostril does not move in respiration. The eyelids of the left side are not closed when he winks, although, when he attempts it, the eye-ball is turned up, the cheek is relaxed, and the forehead on the left side unruffled. These are all symptoms of compression on the portio dura. I find no discharge from the ear. There is no reason to apprehend affection of the brain; and, lastly, just between the mastoid process and the upright portion of the lower jaw, I find an enlarged gland, which is tender on pressure. I hope, therefore, that you will proceed to fulfil your intentions:

"1st. By the application of leeches behind the ear.

"2d, By steaming the side of the head and of the neck with vinegar and water.

"3d, By the use of a stimulating embrocation or liniment.

"I would commence with a smart dose of calomel and scammony, and continue to give an alterative dose of the blue pill at night, with a cupful of decoction of sarsaparilla and lime-water, in equal parts, twice a day.

"I am of opinion that your patient will get quite well, and I shall have pleasure in hearing from you.

"I am, dear Sir, your very obedient servant,

"CHARLES BELL."

By a letter of the 18th August, Mr Hatfield gives an account of his patient's gradual amendment. "He can close his eye-lids; but there is still a heaviness in the lips of the left side."

No. LX.

The symptoms of the following case, in which I was consulted, are by no means uncommon. A gentleman returning from hunting was thrown; he lacerated his scalp, and suffered concussion. He lost a great quantity of blood, was reduced very low, and remained subject to an affection of his head, which years after has returned at intervals. It will come on in consequence of the conversation, heat, and light of a dinner party, even although he does not exceed; and on other occasions any direct disturbance of the stomach will produce it. He has headach and pain along the course of the nerves on one side of the head, a tenderness and indescribable sensation on the scalp, a puffing of all that side of the face, and swelling of the eye-lids of the same side. This, after a day or two, by rest and evacuations, subsides. Still he becomes liable to it on any excitement of the mind, or derangement of the digestive organs.

Such attacks, as I have said, are not unfrequent; and it is only when the puffiness and sensibility affect the seventh nerve that the paralytic affection comes on. Morbid sensibility and tumefaction result from the affection of the fifth, and form the primary class of symptoms. The seventh nerve partaking of the influence, palsy of the corresponding muscles is thus in a secondary way produced; while, by an indiscriminating observer, the pain and the paralysis are attributed to the affection of the same nerve.

No. LXI.—*Disease of the Fifth Nerve.*

Many years ago, I was sent for early in the morning to Lord ——, who had suffered all the tortures of the *tic douloureux*, and had submitted to have the nerve of the cheek (the suborbital branch of the fifth) divided by Mr Pearson. He had been brought suddenly, from the severity of pain, and the recommendation of his medical advisers, to the resolution of submitting to the division of the frontal branch of the fifth nerve.

I performed the operation, marking the notch in the frontal bone, and drawing my scalpel along the inside of the orbitary ridge. What I remarked, with some misgiving of my own precision, was, that no effect was produced on the motions of the forehead and eye-brow, which made me a second and third time draw my knife across the course of the nerve, &c. down to the bone; but no paralysis of the muscles took place. Neither had paralysis of the muscles of the cheek followed the former operation on the second division of the fifth nerve. I treasured these circumstances long in my mind before they led to any formal conclusion.

No. LXII.

" *Chatham Barracks, Sept.* 13. 1828.

" Dear Sir,—The following case, which came under my own observation at the time of its occurrence, struck me as being illustrative of your theory of the nervous system; and as I have watched the progress of your discoveries in that branch of physiology, while a pupil in Windmill Street, with much interest, I feel that I am but performing a duty in transmitting it to you.

" While the British troops were quartered in Portugal last March, Lieut. ——— fell with considerable force from the top to the bottom of a flight of stairs, having missed his step in the dark, when the left side of his face struck with violence against a flag. On seeing him some hours after the accident, I found that all that side of his head and face was much swollen and bruised; he complained of headach and a numbness of the face. I bled him at the time, and ordered aperients and fomentations to the part injured. When the symptoms of injury of the head had disappeared, and the swelling had abated, he continued to complain of numbness of the left side of the face, extending from just below the orbit, along the ala nasi to the tip of the nose, and to the upper lip, exactly as far as the centre of its depression, corresponding precisely with the distribution of the facial division of the second branch of the fifth pair of nerves.

" On searching for the cause, I readily found that the margin of the infra-orbitary foramen, formed by the superior maxillary bone, was broken off, causing a sharp spicula which presses on the nerve, or has divided it at the very point of its exit upon the face.

" It is now six months since the accident, and the side of his face is still quite insensible to the touch, or even when gently pricked with a sharp point; the razor skims over the left side of his upper lip unfelt, and when he applies a vessel to his mouth, a sensation is imparted as if its edge were broken off at the part which touches the affected lip.

" The expression of his countenance is not at all affected, for when he speaks, laughs, or sneezes, the muscles of both sides act in perfect unison.

I am, dear Sir, yours very truly and respectfully,

John J. Russell,

Memb. Coll. Surg. and Assist. Surg. 63d Regt.

" Chas. Bell, Esq. London."

I have noticed, in the text, the effect of injury of the third division of the fifth or mandibulo-labralis to be the insensibility of the corresponding portion of the lip, which, with these two last cases, complete the proofs drawn from experience in the human body, that the sensibility of the face results from the three facial branches of the fifth pair.

No. LXIII.—*Tumour compressing the Mandibulo-labralis.* (*From Note-Book, Aug.* 14. 1834.)

Insensibility of the Cheek.—A gentleman came to me, complaining of a puffiness of one side of his face. He said, he felt as if the texture of his cheek had become loose, and that the side of his face was protruded beyond its natural place and bounds. It was as if stuffed with wool. He particularly complained of his cheek getting between his teeth; and of a numbness even in his teeth; which he thought very extraordinary. He, too, has the sensation of the broken cup put to his mouth; but of late the sensation had " worn out." He chewed with the sensible side, and he was afraid he would wear out the teeth on that side.

Observ.—In the case of paralysis of the portio dura, it is the angle of the lip which is checked. In this affection of the third division of the fifth, it is the inside of the cheek which is checked.

No. LXIV.

Dec. 26. 1829.—An elderly maiden lady consulted me on account of a cancer in the breast: but of all her more favourable symptoms, none gave her so much anxiety as an insensibility of the lower lip. Her attention was drawn to this by feeling only one-half of the cup in drinking. On touching the left side of the nether lip, I found that she had no sensation in all that part supplied by the *mandibulo-labralis* nerve. The motions of her lips were perfect.

Upon feeling deep under the angle of the jaw, I discovered a hard glandular tumour, which was attached to the upright portion of the jaw, and no doubt pressed on that branch of the fifth nerve which enters the internal foramen of the lower jaw.

Mr Drew, of Gower Street, saw the patient with me this morning, and observed the circumstances.

No. LXV.

In the course of the same forenoon I had the advantage of meeting Dr Holland, to consult on the following case:—

A lady, in travelling up from the west of England, was exposed to cold. The left side of her face is swoln and very painful, attended with a ringing in the ear of the same side. She is unable to shut the left eye-lids; she cannot frown on that side; the cheek and mouth on the same side are without expression of any kind. She has a difficulty of speaking, and when she smiles, the face is drawn frightfully to the right side. Fluid falls from the left side of her mouth.

On putting the point of the finger behind the angle of the jaw on the left side, the part is very tender, and a swelled gland can be distinctly felt, which no doubt presses upon, or involves, the portio dura.

The contrast of these two cases, occurring within twenty-four hours of each other, is very striking, and some years ago would have been invaluable to me.

No. LXVI.

Whilst in attendance upon these cases, Mr Sommers, of Euston Square, brought a patient to consult me, in apparently similar circumstances with the last; that is to say, paralytic on one side of his face, with an inability to close the eye-lids of that side. I observed that this gentleman, in detailing the circumstances, pressed his left cheek against the bone with the point of his finger. This was to draw tight the left angle of the lips, which gave him the power of speaking more distinctly, by the motion of the right side of his mouth. This case was distinguished from the others by there being no external tumour, and it was important to notice, that he had some time ago a general weakness of the muscles of the same side of the body, from which he had recovered; that his father had a paralytic seizure, leaving weakness on one side; and that his sister, twelve years before, had been affected in a manner similar to his own present condition; and, moreover, it was observable that he had pain in the occiput, just behind the ear. These latter circumstances gave a character of more importance to this case than to the preceding, where the cause was external.

No. LXVII.—*Affection of the Fifth Pair of Nerves.* (*Case communicated by Mr Crampton of Dublin.*)

"21*st October* 1822.

"L. A. a healthy girl about twenty, received, seven years ago, a blow from a stick on the right eye. The blow must have been severe, as her eye was blood-shot, and could not be opened for several days. From this time she thought the sight never was so good as in the other eye.

About four years since the dimness increased, but she could still distinguish small objects, till June last, when she was affected with a pain in the right ear, deafness, and a discharge. About the same time she suffered from severe headachs, affecting only the right side, and, soon after, she lost the sight of the eye altogether. The motion of the iris remained perfect, but she felt a dull pain at the internal canthus, which seldom abated, and at times there was a copious flowing of tears. Things continued in this state for about two months, when the pain and discharge from the ear ceased, and in a few days more the surface of the eye became perfectly insensible to the touch. This loss of feeling extended to the lining of the eye-lids, to the skin covering them, and to the skin on the cheek and forehead for about an inch surrounding the eye; it did not go beyond the middle line of the face. When she told me that her eye was *dead*, as she expressed it, that I might be certain, I drew my finger over its surface, and so far was this from giving her pain, that she assured me, she could not feel that I was touching it at all. The eye-lids made no effort to close while I was doing this, but the conjunctiva appeared sensible to the stimulus, as a number of vessels on the surface of the eye became immediately injected with blood. At this time a perpetual blister was applied behind the ear, and two grains of calomel given night and morning, with a view of affecting her mouth. After a few days, however, the pain in the ear came on, with increased deafness, but scarcely any discharge; and, at the same time, the sensibility of the eye and surrounding skin returned, and has continued ever since. The sight is totally gone, but she suffers no other inconvenience, excepting the partial headachs, and at times the pain at the inner corner of the eye. She has had throughout a perfect command aver the muscles of the eye and eyelids, and can shut the latter completely. There has been no affection whatever of the muscles of the face.

" 21*st November* 1822.

" On the 25th October, late at night, she was found lying on the stairs in a fit. She recovered after some time, but the fit, with violent convulsions, returned at intervals through the night. From the description given, the fits were not epileptic, but well-marked hysteria attended with the globus, flow of urine, and peculiar affection of mind. I saw her early on the 26th. She had insisted on being dressed, and declared she was quite well. She acknowledged, however, that the headach (hitherto confined to the right side) was now general. Her answers were tolerably coherent, but given in a childish petulant manner. The state of the eye was unchanged. Her pulse was 80, full and strong. She had menstruated a fortnight before, and had always been regular in that respect. I bled her very largely, had her hair removed, and a cold embrocation constantly applied to the vertex; she was also well purged with salts and senna, her feet bathed, and she was confined to bed in a dark room.

" 27th.—She appeared more collected in her mind, but had still the diffused headach. Pulse reduced in strength. She got the senna mixture again, and a large blister was applied to the nape of the neck.

" 28th.—Her head much better. Her mind quite tranquil. Pers^{t}. in usu embrocationis, necnon Mist. Cath^{æ}. et pediluvii.

" 29th.—Headache quite gone; apparently free from complaint."

" Notwithstanding these favourable appearances, I still apprehended that an organic disease might be extending itself in the head, and as the hysteria, from her very full habit, was evidently connected with plethora, I continued the purgatives daily, kept her confined to bed, and on the very lowest regimen."

" November 2d.—She told me that she had felt all night as if there was sand in the blind eye, and sometimes sparks of fire seemed to pass through it. There was no change in the appearance of the eye. On the 3d, when she awoke, these sensations were gone, but she was agreeably surprised to find that her sight was restored. When the left eye was closed, she could see large objects very distinctly with the right, but could not read or discern any thing very small.

" On the 4th, she could read small print, and since that time has continued perfectly well. The sight, she thinks, is not quite so good as in the left eye, but pretty much as it has been since she received the hurt.

" Whatever was the nature of this injury, it appears to have only given the predisposition to disease. The gradual manner in which the sight was lost, and its sudden recovery when her system was reduced by severe evacuation, point out the connexion of her complaint with the increasing fulness of her habit. Notwithstanding the coincidence of pain and discharge from her ear, her case is evidently different from those described by Mr Bell. The only nerves affected appear to have been the optic, and, at one time, the first branch of the fifth pair; and there was no muscular affection whatever. Her ear had been quite well for some time before this last illness.

" *Nov.* 16. 1822."

No. LXVIII.—*Short Abstract of a Case of Disease of the Fifth Nerve.*—(*From Descot*, p. 316.)

It appears that MM. Serres, Majendie, Lisfranc, and Georget, were present at the dissection of this case, and that the following circumstances were stated previous to the operation. The patient had been epileptic; for six months there had been inflammation of the eye, coarctation of the pupil, and opacity of the cornea; the conjunctiva was insensible to a feather; the nostril of the same side was insensible; sulphate of quinine was not tasted on the side of the tongue; the gums were spongy, dark-coloured, and detached from the bone; the hearing was very dull on the right side; the patient could chew perfectly well.

On dissection the fifth nerve of the side affected was remarkably altered. At its origin it was found soft, yellowish, and reduced almost to a jelly; and this derangement could be traced for two lines into the tuber annulare. The nerve, traced forwards, exhibited the same soft, yellowish appearance, excepting the muscular portion, which was natural. The diseased nerve was a line and a half less in diameter than that of the sound side.

I must remind the reader, that, at the time of this dissection, M. Magendie had proclaimed a discovery, than which nothing could be less founded in reason. I had proved that the sensibility of the head and face resulted from the fifth pair; but he asserted that vision, smelling, and hearing, were bestowed through the operation of the fifth pair; and the above dissection was declared to confirm the truth of his discovery.*

Had this assertion been correct, it would have been a severe blow to the students of anatomy. They trace the optic nerve into the eye, the olfactory nerve to the membrane of the nose, and the auditory nerve to the cavities of the ear. But what availed all this, if the French physiologist had proved, instead of the first, second, and seventh nerves, that the fifth was the nerve of smelling, seeing, and hearing?

But, as I have explained in the text, the fifth nerve bestowing sensibility, and that sensibility being the safe-guard upon the organs, we cannot be surprised that those organs should, in the absence of their natural guardian, be irritated and inflamed, and consequently deranged by the disease of the fifth nerve.

This is especially true of the eye. I have taken great pains to explain the apparatus by which it is protected, and the sensibility which excites that apparatus into operation; but when the sensibility is withdrawn, the apparatus is useless, and the eye becomes inflamed by irritation.

I have noticed in the text the difference between the sensibility of the interior membranes of the nose and the power of smelling; the one depending upon the fifth, and the other upon the first nerve. I have also shown that the common sensibility of the nostril was that which excited to sneezing and blowing the nose, and that these actions were to the nostrils what winking is to the eye, the means of removing whatever is irritating or offensive.

But I need make no further observations upon this case; it will be understood, in all its bearings, upon perusal of the preceding papers.

---

* "Cette coïncidence d'une lesion du nerf trijumeau, avec l'altération de l'œil et des gencives, la perte de l'action des sens, est d'autant plus curieux qu'elle confirme les résultats obtenus par M. Majendie par la section des nerfs de la cinquième paire."

No. LXIX.—*Affection of the Muscles of the Jaw.*

I have, in my first, fourth, and fifth papers delivered to the Royal Society, noticed, that the muscles of the jaw are supplied by the fifth pair, a cerebral and voluntary nerve, whilst the muscles of the face, properly, are moved by the *portio dura*, a respiratory nerve. The affections of the latter are very common, of the former more rare, unless in disease of the brain, or in the instance of tetanus.

A gentleman brought his daughter to me: the account he gave would have induced me to believe the case an aneurism rather than an affection of the nerve, there was so much talk of swelling and pulsation. I gave the following *opinion*:—There are, in this lady's case, two distinct subjects of consideration. The swellings to which the side of the head is subject arise from occasional violent spasmodic states of the muscles of the jaw on the left side; the masseter is, from time to time, brought powerfully into action, so as to present to the touch a round hard ball. The temporal muscle, which lies on the side of the head, is subject to alternate actions and relaxations which resemble pulsations.

The second point must be separated. The upper and lower jaws on the left side are deficient in growth. The cause of this defect of growth is very obscure, and the influence, of whatever nature, must have struck and had its effect nine years ago, in childhood. It is beyond control.

The first object will be to remove the local mischief in the sensibility of the gums; and the second indication is to remove, if possible, any source of irritation that may be in the uterine or digestive organs.

This lady returned, about two years and a half after this report, with her mother, who had a nervous affection of the eye: she had not met with any relief in all that time, and despaired of being cured. Its long continuance, however, did not bear me out in my first opinion, that it depended on the state of the gums, but rather on some more permanent disorder of function.

No. LXX.—*Case of Disease of the Nerves within the Orbit.*

Middlesex Hospital, October 1824.—Martha Symmonds, æt. 41. This woman was admitted into the hospital for a disease apparently seated in the left orbit. Nine months ago she had a paralytic stroke, attended with the loss of power in her right arm, and she lost the sensation of the arm, neck, and face, on the same side. She lost, also, her power of speech, excepting only to "babble," as she says. She recovered from this attack, and went into service. About eight or ten weeks ago she was alarmed by a commencing dimness in both her eyes, and she was obliged to leave her place on account of this dimness of her sight. Both her eyes were equally affected, and there was no redness or opacity perceptible in either of them. She placed herself under a medical gentleman because she dreaded a return of the palsy. About six weeks ago the upper eye-lid of the left eye fell, and she could not raise it. At that time she suffered great pain above the left eye, and the pain extended upon the left side of her forehead. She at the same time lost the vision of this eye, although she could distinguish by it the light of day from darkness. She could direct the motions of this eye-ball as well as of the other at that time, and the appearance of the eye was natural.

Five days before she was admitted into the hospital, she experienced a violent deep throbbing pain in her left eye, and from that time the eyeball, as she says, became enlarged, until it projected considerably beyond the orbit. Two days before her admittance she was totally blind in that eye, and was deprived of sensation on the surface of the whole eye, eyelids, the internal corner of the nose, and upon the left side of her forehead.

At present her left eye is covered with its upper eye-lid, and projects greatly from its natural situation. The lower eyelid is everted, as a consequence of the projection of the ball of the eye, and the conjunctiva is tumid and projecting. She cannot raise the upper eye-lid, although, when it is raised with her finger, she can squeeze it down again, and winks with a motion which corresponds naturally with that of the other eye. It may be a question, whether the globe of the eye is enlarged or only protruded. The pupil is unnaturally large, and the iris is without motion. She cannot move the eye-ball in any direction. The whole eye is insensible, she has just had her lower eye-lid scarified, and she was not sensible of pain. She allows us also to press with our finger on the surface of the eye without complaining of any pain, or winking; although, as we said above, she can still wink, and does wink with this eye-lid when the other eye is threatened.

Oct. 6.—To-day some further examination was made of this woman's face and head, in order to ascertain the extent of insensibility. It was stated in our last report that she has lost sensation in the surface of the left eye and eye-lids, in the corner of her nose, and upon the forehead. In these parts, she says that now the loss of sensation is less complete, because, when she had her eye-lid scarified the other day, she felt pain, which she did not when it was scarified before. The eye also seems diminished in size.

Besides those parts which we have already described as being affected, she has, in a partial degree, lost sensibility to touch, in that part of her cheek which is just under the orbit, and downwards upon the side of her nose, and upon the left side of her upper lip, and also within the cavity of the nose on the left side. However, when the point of the pin was brought near to the ear, or upon the skin which is over the lower jaw, she then was sensible of pain. A piece of linen was twisted so that it might be introduced into the left nostril: she allowed us to push it upwards as far as we could, and during this operation she only observed, that she was sensible of its presence. Turning it about within her nostril did not make her sneeze. When we tried the same experiment on the other nostril, she was unable to bear the tickling produced by the loose threads of the cloth, before it was introduced into the nostril. Now she informed us that she is in the habit of taking snuff; and she is not only insensible to its usual agreeable effects, but unconscious of its presence in the left side of the nose. We next made her close her right nostril, and inhale strong spirit of ammonia; and then repeated the same experiment on the other nostril. There was a very obvious difference in the effects produced by the ammonia on the two sides of her nose. She told us she could smell the ammonia on both sides; but still she could not bear to hold the bottle containing the ammonia so long at the right nostril as we observed that she could at her left. When the bottle was placed under the right nostril, its pungency affected her almost immediately, so much that she could not bear it; on the other hand, she allowed it to remain for a considerable time under the left nostril, and even snuffed it up strongly before she was inclined to remove it. During these experiments we observed that the right eye became suffused with tears; the left eye, on the contrary, appeared to be dry in its surface.

In order to ascertain further to what degree her sense of smelling was affected, we tried the effect of some substances which possess odour without pungency. On applying oil of anise-seed to her left nostril, while the right one was shut, she inhaled it powerfully, but was sensible of no smell. Then a piece of assafœtida was tried, but still she had no kind of sensation, either pleasant or the reverse. She was sensible to these odours on her right nostril.

The state of her mouth was examined; with the point of a pencil we pressed against the upper gums, on the left side of her mouth, and the inside of her cheek, where it is reflected off the gums, and she appeared to have either very slight sensation or none at all. She volunteered to put a spoonful of mustard between her gums and her cheek; and she seemed very little incommoded by such an experiment. The sensibility of the other parts of her mouth was natural.

The circumstances of this case make it difficult to determine exactly where the disease is seated, which thus produces the destruction of the optic nerve, the third and fourth nerve, the first and second divisions of the fifth nerve, and the sixth nerve. Among these nerves we might add the olfactory nerve; but it may be made a question whether the function of that nerve is directly or indirectly affected: the issue of the case will probably determine this matter. However, from the condition of the parts without the orbit, we observe, that the power of closing the eye-lid, and of winking, is retained, when the power of raising the eye-lid is gone, and the sensibility of the eye-lids, and of the eye itself, is completely lost. It is the portio dura which is distributed to the orbicular muscle of the eye-lid, and bestows the power of winking. We see, likewise, that she can inhale powerfully, and can perfectly move the muscles belonging to the nostril and upper lip of the left side, when at the same time the skin which covers these parts is insensible. Still that power belongs to the portio dura. This nerve, passing to the face by a circuitous way, and being therefore uninjured by pressure within the orbit, permits her to move the left nostril and the side of her mouth in a natural correspondence with the other side of her face, although both the first and second divisions of the fifth nerve are included in the disease, and are destroyed along with the first, second, third, fourth, and sixth nerves.

May 20. 1829.—Since she left the hospital she has been a constant sufferer. The pain in her head has never left her; it is principally seated over both her eyes, and over the left in particular. For three years she has observed that this pain is aggravated for a fortnight before her monthly periodical return; she says she does not know what to do, her suffering is so great. The pain varies in a remarkable manner with the changes of the weather; she knows when rain is approaching by the increase of the pain, and immediately after it is over the pain is relieved. She has not had a return of the loss of speech, or of the paralysis of her arm, since she left the hospital, but she has had fits, and she has suffered from cramps in the back of her neck and right breast. The arm which was formerly paralytic, becomes about once a month numbed in such a manner that she cannot use her fingers, and this is accompanied with great pain; these attacks do not last for more than five minutes. She walks quite well.

The loss of sensation is principally in the forehead: when pricked with a sharp point in any part as high up as the crown of the head, she had no feeling; but in the temples and below the orbits, and on the nose, she retains sensation. The left eye is blind; the pupil large and immoveable; the motions of it are gone; the surface is insensible; it is clear, and it remains fixed in the centre of the orbit.

The Case continued by Mr Shaw, with observations.

June 1836.—This patient has presented herself again at the hospital. She has recently had a severe attack of inflammation of the right eye, which was sound, and she is now completely blind. A thick white film covers the cornea, and the iris adheres on the inside, so that the pupil cannot be distinguished.

On examining the left eye, it is found to be in the same condition as when she was in the hospital twelve years ago: but it does not now project from the orbit as before. The surface is still totally insensible. Notwithstanding this want of sensibility, and the proof which it affords of the ophthalmic division of the fifth pair being destroyed, the eye has not changed in its appearance: there are no signs of inflammation; the cornea and the humours are perfectly transparent; and the eye-ball has not become diminished in size.

This is inconsistent with the opinions of those gentlemen who conceive that when the functions of the fifth pair are lost, the eye is consequently deprived of its nutrition, and the vital powers are reduced low; and that it is from the influence of these causes that the membranes inflame, and the eye becomes destroyed. It is to be remarked, that, in the case of Windsor, who had a tumour at the roots of the fifth pair, causing insensibility of the surface of the eye, there was no change in the structure of the organ while it continued to be protected by the eye-lid covering it, as in this case: but when the portio dura was affected for a short time, and the orbicularis was consequently paralysed, and the eye-lid ceased to protect the eye, inflammation speedily came on and vision was lost. The inflammation of the eye, accordingly, appeared to result from its surface being no longer defended from the particles of dust by the soft eye-lid; and because it was deprived besides of that equable pressure which the eye-lid, when closed, keeps upon the globe of the eye, so as to prevent it being injured by the irregularities in the circulation, as during the violent efforts of coughing, &c. It is also to be observed, that, when the inflammation commenced, there were no signs of the vital powers being reduced, or the powers of nutrition diminished: the effect of the excited action was, on the contrary, that a thick layer of granulations sprung from the conjunctiva, and the whole eye swelled out and enlarged, instead of being diminished. We may, therefore, conclude that, in this woman's case, the eye has been saved from these attacks of inflammation, which sometimes destroy the eye when the sensibility is gone, by its being permanently covered by the eye-lid and equably pressed.

The patient makes the remark, of her own accord, that the tears do not flow so plentifully on the left side as on the right; and she complains of a dryness in the left nostril: she likewise adds, that when she has been affected and wept, the tears have only been shed from the right eye, and not from the left.

It is to be determined whether this deficiency in the quantity of the tears in the left eye depends on the mechanism which assists their discharge from the lachrymal gland being deranged, or on the sympathies that regulate the secretion being affected in a peculiar manner, in consequence of the nerves which supply the gland being deprived of their functions. It is to be considered, that, since the eye is constantly covered by the eye-lid, there is not the same necessity for its surface being bedewed with moisture as when exposed to the atmosphere: and this may be one cause why the secretion from the gland should be diminished. But it is also to be remembered, that, as the eye-ball is immoveable, and does not revolve upwards in winking, the lachrymal ducts cannot be elongated, nor their orifices opened, nor the gland itself compressed, as in natural winking: and this may interfere with the proper discharge of the tears, even if they are secreted in the usual quantity.

No. LXXI.—*Case communicated by Mr C. W. Bell.*

A woman, æt. 35, subject for some time to headachs, came to the Infirmary in November 1825, with loss of sensibility in the left side of the face. A little sensibility remains only just round the orbit. Ammonia applied to the left nostril excited no change; applied to the right, it causes sneezing and suffusion of the right eye almost exclusively. She complained often of bad smells in the left nostril, and bad tastes in the left side of the mouth, although this side of the tongue is insensible to the touch. She sees dimly with the left eye, and the cornea is rather dull: but there was at first no inflammation. The motions of the eye-ball and eye-lids, and of the features, and also of the tongue, are perfect; but she says she can chew only with the right side of her mouth: and when she closes the jaws the temporal and masseter muscles of the left side are found to be flaccid. She often suffers from pain on the left side of the forehead, left cheek and eye-ball, and sometimes on the left side of the jaws, but always without tenderness. At times this pain has been attended with fever, for which she has repeatedly been bled and leeched with advantage.

In December 1825, her left eye began to inflame, and continued inflamed, though in different degrees, till vision was destroyed. After some weeks the cornea became generally opaque, and a white irregular line formed around it near its base. Immediately after leaving the hospital, from having been exposed to cold, the cornea ulcerated in the centre, and the aqueous humour escaped. The inflammation of the eye increased; and she had violent pain (but still no tenderness), attended with fever. In a few days the crystalline lens came away; the discharge continued, and the eye-ball, after being much swelled, shrunk completely. In the summer of the following year there was no appearance of the cornea or iris.

The headachs afterwards abated, and she got into good health. During the last winter she had a return of the headachs, with a degree of palsy of the tongue, which went off after bleeding and purging. After this she somewhat recovered the power over the masseter and temporal muscles of the left side.

No. LXXII.—*Disease of the Face.*

Eliza Smith.—The following is one of the cases which is demonstrative of the distinct functions of the seventh and fifth nerves.

"The disease from which this woman suffers has been supposed to be that sometimes called *Noli me tangere*, and in its more aggravated form

Lupus. The nose was destroyed by a slow process of ulceration, which opened the cavities of the face, so that we could look into the ethmoid and maxillary cells. At this stage an ointment was used which had the happiest effect wherever it could be applied, and she appeared nearly well. But a small speck of ulceration remained upon the os planum, deep in the cavity: it could not be arrested. The disease in that way got into the orbit.

" The eye-ball became now protruded from the socket, with tension of the eye-ball and tumefaction of the conjunctiva, attended with excruciating pain. At length the eye-ball became so much pushed out, that the eye-lids could not meet; the cornea was continually exposed, and became opaque." (And now the symptoms began to bear on our present subject.) " The sensibility of the surface of the eye, though in a state of ulceration, was lost. She could press her finger upon the eye. The forehead of the same side, the lip, the cheek, and side of the nose, were deprived of sensibility; at this time she could move the eye-lids, although she could not close them from the bulk of the eye, and she had the motion of the cheek and lips.

" When the eye and temple were perfectly insensible, and when, as she herself said, she could pick off the scales from the surface of the eye without feeling at all, she was tortured with the most excruciating pain seated in these very parts; that is to say, referred to these parts."

But on the 28th December there is a note of this patient's case, which describes the swelling as having extended to the temple, the eye as having fallen, and where there was insensibility before, she could not bear the touch of a soft sponge.

" She for some time previous to this complained of a drumming and a weary pain in her right ear; and now she cannot knit her brows, or move the eye-lid, and when she speaks or blows there is a stillness in all that side of the face."

This case requires little comment. The swelling of the parts within the orbit, compressing the fifth nerve, caused insensibility of the part of the face to which these branches were distributed without affecting the motion.

When the tension and swelling subsided, there was returning sensibility; but more than this, the inflammation affecting the nerves in their passage through the orbit gave the sensation of excruciating pain, perceived as if in the face. An inflammation of a nerve does not give perception of pain in the proper seat of the disease, but in the part to which the extremity of the nerve is distributed.

Whilst the sensibility of the face was recovering (by the diminution of pressure on the nerves of the orbit), the motion of the features was arrested. But previous to this the ear became affected, by which it is implied that the seventh nerve had become compressed, or engaged in the progress of the swelling.

OF PAINFUL AFFECTIONS OF THE FACE FROM DISEASE OF THE FIFTH NERVE.

No. LXXIII.

The painful affection of the face called tic doulourenx is seated in the fifth pair, and for the most part in the second division of this trigeminus nerve; and so convinced am I that it is the more direct connexion established betwixt the sympathetic nerve and the fifth that produces this pain, that I could wish to divide the sympathetic in the neck, if I thought it could be done with safety, which it cannot.

The pain of this disease is inexpressibly severe. In the note of the case from which I now quote, the paroxysm begins with much sneezing, and itching of the side of the forehead: the pain begins at six o'clock, and continues for twelve hours, when it is at its height; then the patient cannot speak, owing to the severity of pain; she lies on her right side, and keeps the fingers pressing the temple. As to the kind of pain, I get nothing but this expression:—" It is an overbearing pain." It does not throb; there is no burning sensation, but a shooting and darting; it goes off at once; her head begins to itch, and as soon as the pain is gone she is quite well again.

The seat of the pain is in the right temple and the side of the right eye; sometimes it begins in the right side, and then shifts to the left side, quite as painfully. In the case from which I take this note, the patient says the attack is preceded by a weakness in the stomach, " as if something were alive," and it goes off with the same sensation.

No. LXXIV.

In another case the pain came more suddenly, and struck with more violence in frequent shocks, like those of electricity, and in this patient, too, there was an attempt to stop the suffering by pressure on the nerve. By his experience he had discovered the anatomy of the fifth pair of nerves; for, on the sudden recurrence of the pain, I have seen him apply his hands to his face, and press a finger firmly on all the points where the branches of the nerve make their exit from the bones of the face; pressing one finger on the infra-orbitary hole, another upon the inner canthus of the eye, a third upon the frontal nerve, and a fourth before the ear; and he would stand so, fixed in posture and trembling with exertion.

No. LXXV.

I have an instance before me of the lingual division of the fifth being similarly affected. "In this lady the pain in the tongue is sometimes in the papillæ, near the root, sometimes in the tip, but always in the same side of the tongue. There is no difficulty of speaking, unless from the pain, and yet it is not a soreness, but a burning and smarting—sometimes the whole mouth is affected, even down to the throat, burning like fire."

There is a division of this class of diseases which must be distinguished—painful affections of the face, which do not come from irritation through the sympathetic system of nerves, but from direct injury to some branches of the fifth pair itself; but where the pain is referred to a different portion of the nerve, and generally to the cutaneous or more superficial branch. We have an instance of this in the severe pains which attend the shooting up of the dens sapientiæ in a narrow jaw; in the distress which attends disease of the antrum and caries of the bones of the face, through which the branches of the fifth pass to the face.

No. LXXVI.

Note.—Mrs S. For fourteen years she has experienced pain in the *eminentiæ frontales* (she places the points of her fingers there); of late the pain has been more in the root of her nose; when seized with a paroxysm, the tears flow from her right eye in a stream; when she touches the right nostril a pain strikes to her forehead; sneezing, and still more coughing, gives her great pain; laughing and crying have the same effect; bringing the teeth together brings on the pain; washing the right cheek with a soft sponge brings on the pain; any change in the temperature of the atmosphere affects her; when she goes into the open air, or when, after having been out a little, she comes into the house, a sharp pain darts up to the forehead. On examining this patient's mouth, the teeth were observed to be black, and the gums unhealthy and ulcerated: on removing two of the anterior molares of the upper jaw, matter flowed from the antrum. On her next visit, I still found the fangs of another tooth remaining buried in the gums, and the adjoining teeth black and the gums spongy. These I ordered to be removed also. After this she could press the side of the face without exciting pain, or bringing on the paroxysm, as heretofore. On her next visit, the gums appeared healthy, the pains were much relieved, but still periodical: the solution of plumbi acetatis and opium externally applied continued to give her immediate relief.

Such are not the symptoms of the true *tic douloureux*, but of that case where the internal branches of the fifth pair, being irritated by disease, produce pain in their external branches.

We have another set of symptoms, and from a more formidable cause, in the following note, which I take also from my private case-book.

No. LXXVII.

Mrs. F.—The burning sensation commenced on the left side of her tongue, and has gradually increased for twelve months, until it now extends over half the tongue, and mouth, and face, and head. It is a sensation as if her mouth were burnt; she has lost the sense of taste in the affected side of the tongue; she is not aware when a portion of meat is lodged betwixt her tongue and cheek. There is a numbness of the corresponding side of the face, which she says is like the pricking of a thousand needles, as when the hand or foot goes to sleep by pressure on the nerves. The end of a feather passed three inches into her left nostril gives her no sensation, and does not produce sneezing; yet she has the smell of both nostrils. On making her describe the extent of "deadness" with her finger, she runs it round the left side of the chin, and on the side and ridge of the nose. She imagines that there is a dryness of one side of her mouth, but it is not really so; there is no difference in the sides of her mouth to appearance. The pain is aggravated by speaking or by eating; and still more by coughing or sneezing. When she moves and twists her face, she says there is much stiffness to her feeling; but the action to all appearance is quite entire. She says that "the side of her face is, in a manner, dead; and yet it cannot be dead from the constant pricking upon it."

The affected side of her face is subject to become swollen, red, and livid, and extremely hot; so that to allow her to sleep, she must then keep the lotion applied. She says she thinks she must die but for this lotion (solution of opium and plumbi acetas). It is remarked, that to relieve a painful itching at the back part of her ear and on the temple, she pinches the skin, but does not scratch it, for then great suffering is the consequence, and the pain extends all over the side of the face.

Such symptoms I conceive to come from direct disease of the fifth nerve, or from inflammation involving it.

Continuation of the preceding Case by Dr Whiting.

"Mrs F. called on me, August 2. 1827, for advice for a disease of which she gave me the following history:—

"Twelve months previously she first felt an unusual sensation on the left side of the tip of her tongue as if it were burnt; this feeling soon extended over the left half of the organ, and afterwards over the left side of the palate, gums, and face; it was accompanied by an almost total loss of the sense of touch in the parts affected. The uneasiness had been constant from its commencement, increased, however, by the motions of the face, and by the contact of the hand on any solid body.

"At the period when I first saw her, the boundaries of the disease were, the ridge of the nose, the raphe of the upper and lower lip, the lines which mark the division of the right and left sides of the palate and tongue, the margin of the left lower eye-lid, the anterior edge of the meatus auditorius externus, and the horizontal ramus of the lower jaw. In none of the other parts of the face was there any evidence of disease. The morbid condition of the parts affected were as has been described; both taste and feeling were lost from the left side of the tongue, so that she was obliged to chew on the right side only, and if the food lodged at any time between the teeth and cheek in the left side of the mouth, she was obliged to remove it with the finger. The motions, however, of every part of the face were properly performed, the features not at all distorted, the tongue protruded in a straight line, the temporal and masseter muscles appeared to act powerfully on both sides; she had no difficulty in utterance, except occasionally, when much excited; her general health seemed good, her appetite was strong, her bowels were confined, and her tongue rather white. Since the age of twenty-one a violent headach had frequently distressed her, which she described as going off by the face; it was accompanied with sickness and vomiting of bile: this headach had continued to return at intervals since the commencement of her present ailment.

"On 8th October 1827, I find I reported that the symptoms had gradually increased in severity, and the disease extended somewhat beyond its former boundaries.

"September 1828.—From the last date to this she had been nearly lost sight of by me; she had been for some time under the care of Mr Charles Bell. On visiting her at this time, I found that she still had a distressing sensation on the left side of her face, &c., although altered in its character; her speech had become indistinct, her face was drawn to the right side, the masseter and temporal muscles of the left side had ceased to act, the tongue was protruded towards the left side, the hearing of the left ear had ceased; she could raise the left upper eye-lid by voluntary power, but could not keep it elevated; the effort to raise the globe of the eye was attended with headach and giddiness; there was considerable secretion of tears; she was emaciated and bed-ridden, and complained of great and constant pain at the back part of her head.

"About a month before her death her intellects became confused, her breathing difficult, her speech quite indistinct, and her deglutition impeded; she occasionally ground her teeth with violence, and her jaws were often firmly clenched, apparently by the contraction of the muscles of the right side: she seemed to die at length (in February 1829) from difficult respiration, and want of the power of swallowing.

"*Post-mortem appearances.*—The frontal bone was more than one-third of an inch thick, and studded with numerous granulous eminences, causing corresponding indentations on the surface of the brain; the vascularity of the dura mater was increased, but not more adherent than usual to the bone; the substance of the cerebrum and cerebellum had more blood than it is generally found to contain after death, but was otherwise of a healthy appearance; about one ounce and a half or two ounces of serous fluid was found in the ventricles; a tumour containing fluid of the colour of urine (considerably darker than that taken from the ventricles), about the size, and not unlike the form, of a pigeon's egg was discovered on dividing the tentorium on the left side, bounded by the petrous portion of the temporal bone, the pons varolii, and the left lobe of the cerebellum; the part next to the pons had contracted a slight adhesion to it, and had, by its pressure, produced considerable indentation on the left side of it; the tumour seemed, on minute examination, to be a growth from the inferior surface of the crus cerebelli, just behind the junction of the pons varolii; this morbid growth consisted of a bag, partly membranous, and partly medullary, the interior of which was cellular, and contained a fluid, which has already been described in a manner, not very unlike the vitreous humour of the eye, excepting the colour of the fluid. The first and second pair of nerves on the left side were as usual; the third was slightly displaced by the tumour; the fourth undisturbed; the fifth appeared to come from the fundus of the tumour, passed under the dura mater at its usual place; it was flattened and thin as if from pressure, and could be traced along the coat of the tumour no further than within about half on inch of its origin. The sixth pair was healthy; but the seventh, both portio dura and mollis, was completely involved and lost in the tumour from a quarter of an inch from its origin to the meatus internus; and into this foramen no nervous structure could be seen to enter, but a substance resembling the membranous portion of the tumour and apparently a process of it; both portions of this nerve, however, were distinct from each other at their origin, and of their usual appearance.

"JOHN WHITING, M.D.

"250 *High Street, Southwark, March* 1829."

From whatever cause it may proceed, whether from the more exquisite sensibility of the fifth nerve, or its more remarkable connexions, certainly all nervous affections are peculiarly apt to fall with a concentrated force upon it. Thus, in injuries of other nerves, the first symptom, before the affection spreads to the other voluntary muscles, is stiffness of the jaws. In several instances of injury of the nerve in amputation, also when the nerves have become entangled in the cicatrix of the stump, the pain has struck into the face and jaws, producing a tic.

Returning to the subject of tic douloureux, I prefer transcribing the note of a clinical lecture.

Clinical Lecture on Tic Douloureux, delivered at the Middlesex Hospital.

Before leaving this hospital, I mean to give you some clinical remarks;

a practice which I have pursued for one and twenty years: it was my earliest duty, and it shall be my last, to the pupils of this hospital.

No. LXXVIII.

There is an indescribable pleasure in reflecting on the successful treatment of diseases attended with pain amounting to agony. On Thursday last re-appeared a patient (Charles Delafield) in whom some of you were much interested during the early part of last summer. He presented himself a miserable object; his head surrounded with a night-cap and rolls of flannel, which almost hid a face, pale, and wasted with incessant pain. Seeing him so proper an object for the charity, I gave him a letter, and wished him to come into the house. He expressed himself grateful, but he dared not; for he could not bear the restraint even of lying in bed, and had no relief from pain but in continual work in his business, which was that of a carpenter. His complaint was *tic douloureux*, and of that most severe kind which fixes in the centre of the cheek: it came like a flash of lightning upon him. I exhausted my little store of remedies, and still he returned, not weekly, but daily, a miserable object—a study for the painter, if he desired to design " the last man,"—a man despairing.

After some weeks of attendance, one morning (whilst I was surrounded by the out-patients) this man, not waiting his turn, burst through the crowd, calling out he was cured! This, no doubt, he did from his confidence in the interest young and old had taken in his sufferings. I knew not what I had given him, but looking at his card, I found the following:—

℞ Ol. Tiglii (Croton) gtt. j; Mas. Pil. Colocynth. Co. ʒj. Misce et fiant. pil. xii. Mitte. Pil. Galban. Comp. xii.—One of the purgative pills and two of the gum pills to be taken on going to bed.

The pills operated quickly, and rather violently, upon him; but he continued them; the pain leaving him, and a remarkable change taking place for the better in his countenance, no doubt from his obtaining sleep as well as freedom from pain.

Before I go further, I shall recal your attention to the pathology of this complaint, and venture to repeat what I formerly stated to you. It has appeared to me surprising that authors have omitted to found on the anatomy of the nerves, which leads so directly to the satisfactory explanation of the symptoms in this disease. The sympathetic nerve we have seen to be a whole system of nerves, spreading every where, possessed neither of sensibility nor power over the voluntary muscles; it is nevertheless acknowledged to have important offices in controlling and combining the whole economy of the system, and to have its centre in the abdominal viscera. The very circumstance of its affording no phenomena like other nerves, should lead us to conjecture that, as this system resembles in structure the nerves of sensibility and motion, it must have powerful, though secret, influences.

I was careful to point out to you, that the connexions of this system, or (if you will) of this nerve, are universal; but that the habits or mode of demonstrating it leads us to pay more attention to the branches which extend into the head, though neither larger, nor probably more important, than those which extend into the plexus of the axilla, or into the sacro-ischiatic nerve.

Are we to admit or to deny this influence of deranged bowels—of visceral irritation—in producing external pains, local paralysis, or partial spasms? No man who attends to disease can deny the existence of this influence. Taking this as admitted, the line of connexion is clearly laid down in the anatomy.

Nor can we deny, I think, the effect of the confluence and mixing of internal nerves with such as go to parts external and exquisitely sensible; and that, through this connexion, external pains become significant of internal disease, or more commonly of irritation and disordered function.

One step further in this inquiry. The fifth nerve is the most exquisitely sensitive of all the nerves of the frame: the sensibilities it bestows are enjoyed in a higher degree than those produced through any other nerve of the system. It is also the seat of most severe pain.

Impressed with these facts, the moment that we see the map of the relations of the sympathetic nerve with the second division of the fifth, by a large and direct branch, and lesser connexions of the same nerve with all the branches of the fifth, we surely need look no further in explanation of the frequent and intimate dependence of a painful affection of the face upon the state of the digestive organs.

It is rather remarkable that Mr Abernethy, who did so much to direct the attention of the profession to the influence of the stomach and bowels on local affections, should have abandoned his ground on the occasion of the triumph of the principle. I allude to that passage of his work where he writes, “ I shall only say, that to me tic douloureux appears, in general, to be as much a constitutional affection as gout or rheumatism; and that constitutional treatment is that which seems most likely to be of advantage in this as well as in nervous affections generally.

Most certainly the mere exhibition of blue pill and the bitter draught (though they will alleviate) will not cure the painful affection of the great nerve of the face. But consider the length of the intestinal canal: above all, consider how strangely distinct portions of that canal are affected by different medicines. Does not this imply a distinction in portions of the tube, which may, in their disturbed condition, affect remote parts, and with various effects? This, I confess, has long been my opinion; and that, although the common means of relieving a headach, or a megrim or clavus, may fail in this, yet that we ought not to despair of finding a purgative which, peculiar in its properties and effects, may reach the seat of this irritation, and may consequently influence the tic douloureux; and what more likely than the croton, in proper combination? I was acting under this conviction when I prescribed the croton oil.

But let us return to the result of experience. Since the period when Delafield appeared suddenly among us, like him who drew Priam's curtain, I have had four cases of pure *tic*, cured by the same means.

No. LXXIX.

The first instance was in the lady of the Rev. R. H. of Kent. She sent for me to the hotel; she described her sufferings, the nature of which I shall presently narrate. I prescribed for her, and took the precaution of recommending her to shew the prescription to her medical friend in the country, and to make him a party to the proceeding. After some time she returned to town, with the most animated expressions of the benefit she had received; and on Friday last I saw this lady's husband, who spoke only of the fear of the return of the disease.

No. LXXX.

I shall state a case, almost within your own sphere of knowledge, since the lady was attended by Mr Wood,* late house-surgeon, and who shews his regard for the old hospital by being occasionally with us:—

Mrs W. came to Gordon's Hotel, to be under my care and Mr Wood's. She looked miserably, being continually in dread of pain. The attack begins by a deep and agonizing pain on the right side of the nose or cheek; it then ranges to the back of the head and neck, returns through the roof of the mouth, and fixes in the place first affected (the canine tooth and lateral incisor tooth are exquisitely sensitive); and this is its course invariably. "The pain is periodical; it has not varied, in the time of its return, five minutes for eleven weeks. It attacks her at one o'clock in the morning, whether she be asleep or awake. Last Sunday night she sat up till one o'clock, to see whether she could prevent it; but it came at the appointed time. It continues from one till eight, when it gradually abates; during all this time she cannot remain in bed, but walks about the room. The attack recommences at half-past ten in the morning."

In conjunction with Mr Wood, I gave this great sufferer the combination of pills I have mentioned to you; and the report, after three days, was to the effect, that "the pain does not come on till three hours after the usual time of attack, which time she has gained for refreshing sleep."

She went for a week to the neighbourhood of Windsor; returned in a few days: resumed her pills, the ol. tiglii being increased to the sixth of a drop in each pill. She had also a comforting draught, with infusion of gentian and of cloves, with tincture of orange-peel and spirit. ammon. aromat.; and on my second visit after her return, I had the pleasure of seeing her in great spirits, and entirely free from pain.

---

* Now practising in Bolton Street.

No. LXXXI.

On the 17th of this month I took this note of a lady's suffering from tic douloureux:—" She acknowledges to have bad health; she has weak digestion, flatulence, no acidity, but torpid bowels constitutionally, which obliges her to take a little pill. She thinks her complaint commenced from cold, caught in driving in an open carriage; it has continued fourteen weeks; it is a violent pain on the cheek-bone, in the eye, and in the temple. The pain is so violent and so sudden, that she compares it to what might be the effect of a blow with a hammer on the eye; it comes on whilst she is sitting at dinner; the eye pours out water. The pain usually continues from one till five in the afternoon. She is well at night, and passes the hours of sleep tranquilly; she has swallowed pounds of iron; has used veratria externally."

I hope to report favourably of this patient; having recommended her to continue under her excellent physician, with the hints as to medicine which I have given you, I need hardly add, that before these patients came to me, they had tried bark, steel, ammonia, arsenic, belladonna, and iodine, and all the usual remedies to correct digestion. The belladonna and blue pill was the medicine which the late Dr Warren depended on. The external application which the last patient found to be most beneficial, was laudanum and tobacco infusion.

Some have appeared to me to confound the disease of the nerve with the true tic; and I would preserve the name, to distinguish it from various other painful affections of the face, necessarily seated in the fifth, which is the only nerve that bestows sensation here. We have had in the hospital patients suffering from excruciating pains of the face, from disease of the parts surrounding the nerve; and no doubt similar pains arise from disease of the bone; but you will have no difficulty in distinguishing the true tic, by the suddenness of its attack, by the perfect intermission, and more especially by the circumstance of the sensibility of the parts, and the action of the muscles, being unimpaired; whereas in those painful affections which arise from the actual presence of disease, there is numbness of the parts supplied by the branch of the fifth nerve which is affected; or the nature of the complaint is evinced by the inflammation spreading to the third nerve, and affecting the eye-lid.

I must not dismiss this subject without adverting to the opinion expressed in a work which is in your hands—the Lectures of Sir Astley Cooper, by Mr Tyrell. I allude to the passage where he describes the operation of dividing the branches of the fifth nerve; and not these only, but the portio dura of the seventh nerve, which is described as the most frequent seat of this disease. I wish Sir Astley Cooper had looked to this passage, and given it the safeguard of a note: nobody is better aware of the effect of the division of the portio dura, since I formerly told you that, directly on the publication of my first paper on the nerves, he furnished me with examples of the effect of cutting it across.

But the division of the branches of the fifth, though it has been practised by every surgeon of eminence during the last half century, is not to be done. It produces only the effect of a severe impression; the advantage is temporary, if any, and the root of the evil is not reached.

The complaint the most likely to be mistaken for the true tic douloureux, is that pain felt on the superficial branch of the fifth consequent on disease of the bone or sockets of the teeth influencing an internal branch of that nerve. But this can be ascertained by careful observation.

On the whole, that disease which is marked by the sudden and violent pain—as, when a patient, in speaking to you, starts as if lightning had struck him, and applies his finger to his face and to the branches of the fifth pair of nerves, the infra-orbitary or superciliary holes, or angle of the eye, and when he remains thus holding his head, speechless, and rocking on his seat—such a pain will not be mistaken for the disease in the nerve: it is the true *tic*, as I must presume, depending on remote irritation.

To sum up, I feel authorized to say, that the tic douloureux is of that class of pains where the irritation of internal parts affects an external and sensitive nerve; where the disease is not actually seated in the nerve, but results from a remote irritation. Nor is it the consequence of disease embracing the trunk of the nerve affected; as in the patients from whom these preparations before me were taken. I feel equal confidence that the source of the disease is in the abdominal viscera—not arising from disease otherwise formidable, but rather from disordered function, which I apprehend to be the reason why patients suffer for a long succession of years unsubdued in strength, unless by sleeplessness and the exhibition of poisonous medicines which are in vogue.

I have stated to you that I have had five cases in succession of painful affections of the face, varying considerably in their character: some where the pain shoots suddenly, and for a short period, and coming irregularly: others strictly periodical, and these cured by the very simple means I have told you; the sixth may be a failure. But these are sufficient to countenance the opinion I have offered; and that you are still to seek the means of relief by correcting the morbid condition of the viscera.

After the date of this lecture I had several patients affected with *tic*; and indeed I sought for my old patients to give them the benefit of the croton. In all the benefit was obvious, but not so entirely happy as in the cases mentioned. However, I consider its effects to be so very remarkable, that it confirms my view of the cause of the pain; that its source is in a disordered function of the abdominal viscera;[*] and that, without placing too much dependence on specific remedies, we must seek the cure in the correction of the disordered digestive functions. The cases which follow are given not for the purpose of pointing to remedies, but to complete the history or description of those neuralgic pains.

No. LXXXII.—*Case of severe Tic.*

—— —— wounded at Waterloo. The head of the tibia split by grape shot: carried to the village of Waterloo, and the limb amputated above the knee: a flap formed of the upper part of the integuments: the wound healed within the month. In a short time appeared at Court with a well-shaped wooden leg. Fell often, and hurt the stump: exfoliation took place, and a circle of the end of the bone separated. The stump was still subject to exfoliation when the nervous attack began: remembers a small piece sticking out, sharp as a piece of glass, which was withdrawn by the scissors. The first large piece was taken out by incision, and with great pain.

The attack of tic douloureux began suddenly, and with violence. The first attack took place when he had accidentally struck his tooth with the tooth-brush. He has had teeth drawn without relief. Dr Pemberton (to whom he went with the sound tooth in his hand) said, " Let them draw no more; I have had all my teeth drawn; the teeth have nothing to do with it;" and, poor man, he was interrupted by pain while he spoke to me. —— —— has a gold case over the grinding teeth of the upper jaw of the left side. (The attack is confined to the right side.) On the right side the second molaris of the upper jaw has been excavated and filled with gold. The attack of pain is confined to a spot definable by a line: he carries his finger round under the eye to the side of the nose and inner angle of the eye, before the ear, and a little down on the neck, and along the base of the jaw.

His present physician says he could feel a mass in the colon, which is now removed. He has passed very particular scybalæ, and his stools are a strange tough mass; a quantity of lymph has been washed from the stools and preserved.

In the end of the stump there is a mass of the size of a pigeon's egg, upon the extremity of the popliteal nerve.

---

[*] The publication of the clinical lecture gave occasion to a letter from Dr Kerrison, claiming to have pointed out the nervous relation which causes the fifth nerve to be the seat of pain. It is so very long since the Doctor and I met on the case of the late Lord Carlisle, that he may well have forgotten my opinions then delivered, as well as his having witnessed the demonstrations of the nervous system in the lecture-room in Windmill Street, consequent on our consultation.

No. LXXXIII.—*Tic combined with other symptoms.*

Mr F———. With Mr Martin. Complains of pain in the left temple. He has been distressed with it for fifteen years: he attributes it to an accident: a statue fell on him and stunned him: he had sick headachs before that. His pain attacks him in the morning, and especially if he has been lying on his back; after an hour it becomes worse, and at mid-day rages terribly. During the attack the pain comes on every two or three minutes, attended with faintness and sinking, and extends from the temple to the heart, and he feels as if there were an enlargement there.

His attack returns once in ten days. " He had it yesterday week, and it will come on one day next week.

No. LXXXIV.—*Tic Douloureux.*

——— an elderly lady. The pain is in the *mandibulo-labralis;* it extends to the side of the ear and temple, sometimes on both sides, but always more on the right; it affects the side of the tongue and side of the throat, and penetrates into the eye; sometimes the right shoulder and arm is slightly affected. In one tooth the pain is sometimes so great that she thinks she must faint. It comes on from eating a crust, or talking or reading aloud. She has sometimes been free of the pain for three months. She acknowledges habitual and great constipation.

No. LXXXV.

" I fear I shall not be able to render to Sir Charles, in a manner that may be brief, a statement of sufferings, and a mode of treatment of the same, which has now extended over a period of nearly nineteen years. I will, however, seek to generalize as much as lies in my power.

" In the month of November 1817, in passing down Sackville Street, a most acute pain suddenly seized me on the surface of the middle of the right thigh; I cannot imagine a stroke of lightning more instantaneous in its nature; the pain lasted but for a moment, and came in intervals of two minutes, with the like electric shocks. Reaching home, I went immediately to bed, and the pain continued for eight hours. The cessation was as sudden as the attack, and then the part became as sound as it was before, and could bear hard pressure, whilst, when the pain was on, it had been exquisitely tender. Some few days elapsed ere the torture returned, which was of precisely the same nature as the first attack. All this continued till May 1818, during which time I had medical advice, and tried a great variety of medicines: during the summer and autumn I was free from the pain, but not at all in a good state of health. In the October following the pain returned with renewed violence, but not confined now to the thigh as heretofore, but affecting the lower limbs, the fingers even, and oftentimes the side and breast, though never at two places at once. In the spring of 1819 I consulted Mr Pearson of Golden Square, and took, under him, of almost every variety of medicine,—salivations, warm baths, &c. &c. without relief. In the summer I saw Sir A. Cooper and Sir M. Tierney; still no cessation of pain. I took the carbonate of iron, as recommended by Mr Hutchinson. In 1820 I tried the "recumbent position" for five months, in pursuance of an opinion expressed by Mr Copland, that some affection of the spine might be the cause of my great sufferings. I was at the same time attended by Mr Abernethy. All these measures brought me no relief. In 1821 I was under Sir Charles Scudamore. At the close of that year I went to the south of France, and saw, at Paris on my way, Mons. Dupuytren; he recommended minute doses of opium. In 1822 I visited the baths of Barèges in the Pyrenees; and whilst taking the waters, and bathing seventy successive days for three quarters of an hour each time, I was certainly more free from suffering, but on leaving the place the pain returned as badly as ever. The five following years was but a repetition of the preceding, constantly under some fresh course of medicine. In 1826 I again went to the Pyrenees, and again found temporary benefit, more especially as regards my general health; although I have constantly found that, as my strength may increase, so also does the pain increase in violence. The last eight or ten years have not in the slightest degree changed the character of the complaint; again and again have I tried the several means I had previously resorted to, and under the same distinguished surgeons and physicians. At the suggestion of Sir A. Cooper I made a trial of the "German Spa" waters at Brighton,—the "Carlsbad," —and most certainly with great benefit, temporarily. These I have taken three several seasons, and each time with longer intervals of ease, and have hitherto looked forward to them as likely to repair, in some degree, the ravages of "black drop" and other narcotics, to which I have been compelled to resort for alleviation. All this brings my "woful" catalogue down to the month of March 1836, when, at the recommendation of Sir Charles Bell, I took the 1–6th of a drop of croton oil, combined with other things. The first pill I took on the 5th of March; the following day I had a most severe attack: the two next nights I took the croton oil, and which acted each time very violently, accompanied with strong griping, and this to me is altogether unusual. The medicine I found reduced me very much, but I had no recurrence of pain; Sir Charles therefore proposed my taking the twelfth of a drop, and a tonic besides, in the course of the day; and most surprising have been the results,—fifteen days without "the pain" to any violent extent, and eight days out of the number without pain at all!! whilst, during the preceding four months, I had hardly a twenty-four hours without my suffering dreadful torture.

"28 *Piccadilly*, 21*st March* 1836."

Still this patient was not cured, but continued to suffer. On a succeeding day we have the following:—

"I may almost say I have tried every thing in the way of relief, and that too pertinaciously,—salivating, caustic, issues, setons, blisters on the head and spine, continued for weeks,—argentum nitratum, arsenic, belladonna, veratria, quinine, &c. &c. When the pain is seriously on me, I have sometimes found relief, and instantaneously so, from scalding or burning the part affected; a common smoothing iron applied of a moderate heat, and held as long as I am able to bear it, will then bring on an *itching* sensation, and, when that is the case, invariably the pain ceases."

No. LXXXVI.—*Tic Douloureux.*

2d July. P——, 28 years of age. He has suffered pain in the face for two months,—it is in the cheek bone; at first aching like the effect of a blow. When it shoots up to the temple it is distracting. It comes on twice in the day. (The pain began on the opposite side to that now affected.)

His general health not good; he is subject to distention of stomach, indigestion, and constipation. The dentes sapientiæ of the upper jaw are both dead stumps.

23d, Returned quite well. He had the teeth extracted. Abscesses were found at the roots. The gum bled for three days. (He had a sister who bled to death; it is a family peculiarity.) His medicines were two blue pills at night, with a draught in the morning of rhubarb, carb. of magnesia, tinct. of senna, followed with large doses of quinine.

No. LXXXVII.—*Tic Douloureux.*

July 11. An elderly lady. For three years she has been a sufferer. At that time she had a tooth stopped. Afterwards the tooth was removed without advantage. Her pain is of a violent darting kind, and strikes to the ear: its seat is low on the cheek; sometimes it is in the lower jaw, sometimes in the face. I see her starting under the pain; and when she is about to speak to me she starts, and is fixed in pain, and cannot utter a word. The husband broke in with the remark, "I see her case is exactly that of the carpenter's;" by which I learned that they had been reading the case page 355, and that their medical attendant had given them the medicine prescribed there, and that for a fortnight from the time of taking it she had been free from pain. But now she is again a sufferer, and has not slept for five minutes all last night. She insists upon being in perfect health, having neither flatulence nor acidity nor irritation of bowels, only inclined to constipation. The croton had not purged her. I gave her the sixth of a drop in a pill, with a morning draught with rhubarb, magnesia, manna, and ol. cassia, in spirit of nitric æther, so as to procure a full relief from the bowels every day. On the 23d she had no relapse, and I suppose I shall not see her again.

These cases confirm me in the belief that the pains of the face, so fixed that we must incline to believe that there is some local disease, are to be remedied by the correction of the peculiar irritation in the viscera on which they in truth depend.

No. LXXXVIII.—*Pains of the nature of Tic Douloureux in other parts of the frame.*

The handsome Lady —— has been married on crutches. I was consulted some three years ago, and then she had suffered for seven years! The pain is in the ankle-joint, just anterior to the inner maleolus. There is no puff; no visible indication of disease. Yet exercise brings on the pain to an insufferable degree. She had then been treated for disease of the joint. Does not this length of time without disfiguration of the joint, or local inflammation or fever, countenance my opinion that the pain was nervous, and to be differently treated?

No. LXXXIX.

The pain began when in a constrained position on horseback. Went off. When it now attacks him it shoots down the thigh (he runs his finger in the course of the saphenus nerve), and turns in towards the fork. The pain is like the shooting of the nerve in toothach. Returns at no regular time. Wine will bring it on; and indeed taking his tincture will cause it. Walking or standing brings it on. Brodie asked him whether he were subject to piles? Guthrie asked him whether he had any complaints in the urethra?

No. XC.

I attended Miss D., a lady of a cultivated mind. She described her suffering in very animated language. She had been confined to her room for years, and passed most of her time kneeling by the bed-side. She took in the course of the twenty-four hours five hundred drops of laudanum. After visiting her several times I prevailed on her to let me see the part then affected with scalding and burning, for I expected to find the hip and thigh one extended ulceration. There was no disease, not the slightest discoloration! However, if we cannot relieve these pains, it is cruelty and ignorance to call them imaginary.

A burning sensation is common; but I have had patients who not only complained of partial and extreme coldness, while the part, the side of the face, for example, has been remarkably lowered in temperature.

A sensation of scalding very often accompanies the morbid nervous sensations of the lower extremity of the hip and scrotum. This is a sure

the pain proceeding from the state of the bowels. It is remark-
ıat this sensation will be attended with tenderness on pressure.
ensation will sometimes attend the progress of a purgative through
estines.

No. XCI.

his class of affections a case the most extraordinary in its conse-
s occurred during my last day's attendance on the Middlesex Hos-

ung woman was received into the house, supposed to be labouring
disease of the knee. A consultation was called on the question of
ition. There appeared to me no indication of disease in the joint,
e pain seated in the knee stretched down to the heel. It was so
that the poor young woman was prepared to submit to any remedy
omised relief. I was decidedly against the operation. A consul-
was again called, I was absent, and amputation was performed.
he healing of the stump, the same pain was felt, still as if in the
nd heel and side of the foot. It was now proposed to cut off the
ity of the bone and cicatrix. To this I had no objection. It was
but proved no remedy to the severe paroxysms of pain. It was
roposed to divide the popliteal nerve in the back part of the stump.
young woman wished something to be done (though this is really
ifiable reason), and as the surgeon was confident, I did not object,
gh I thought the disease was not in that nerve, or rather in its re-
. The operation was performed, but without the expected result,
n continued.
came a proposal, which I confess startled me; to take off the limb
hip-joint! To this I most pointedly objected. Cases were stated
cure of such affections by a similar procedure. It was said that,
euralgic pain in the hand, the hand, the arm, the shoulder, had
uccessively amputated with success. I did what I never found
ary before. I protested in writing against the operation. The am-
n at the hip-joint was performed. It was successful, that is to
e surgeon had to boast that he had amputated at the hip-joint and
tient survived; but as to the cure of the pain, who in reading
ases can have hopes of benefit?

No. XCII.—*Neuralgic Pains in the Upper Extremity.*

lady is the wife of a clergyman in Essex. She accidently cut her
Sir Astley Cooper cut across the nerve under the impression of
g partially divided, and that her severe pain arose from this cir-
nce.
pears that on the accident to her finger, a red line was observed
g up the arm, followed by pain and swelling in the arm-pit. Her

pains are dull; they extend down the arm, and round the shoulder. She is here in great alarm, lest the nerve on the other side of the finger should be divided as had been proposed. I think that, in consequence of the absorbent being inflamed, and the gland in the axilla enlarged, the nerves have been engaged, and that the symptoms depend on that circumstance. Better to soothe the part and the whole arm by fomentation and steaming, and to fortify her constitution against nervous irritability.

No. XCIII.—*Pain of Elbow.*

This lady's pain commences in a spot of half-a-crown in circumference on the top of the right scapula; extends down to the inside of the elbow, and to the thumb and ring-finger. She has been informed it was liver by Dr Babington and Dr James of Croyden. The mamma of the lame side partakes of this pain. She acknowledges great depression of spirits.

Remark.—These pains of the breast and arm are very common, and give rise to apprehension of disease in the mamma. Too often I have witnessed advantage taken of these pains. I have seen the breast covered, and the woman enveloped in ten yards of roller, on account of disease of the gland, when there was only this pain, arising from a source internal.

No. XCIV.—*Nervous Affection from overstraining.*

Miss G., a patient of Mr Callaway's. In pulling repeatedly on a stop-bell she sprained her arm, and to this she attributes her complaint. This is countenanced by the pain and flat tumour of the wrist, feeling like an effusion into the sheath of the flexor tendons. Her fingers are bent, and it gives her pain to extend them. She is subject to a pain which extends up the arm to the side of the neck, and to the origins of the nerves of the axillary plexus. She has been treated by fomentations, and embrocation along the nerves of the arm; the wrist and fingers have been supported on a splint, and the fingers have been gently and gradually straightened, with opium and belladona plaster to the wrist. Her medical treatment has been chiefly steel combined with valerian and carbonate of soda, and an active purgative pill.

No. XCV.

A young lady, æt. 26, Kent Road. Her attack commences with a contraction of the little and ring finger, attended with great pain, then contractions of all the arm, followed by fainting. Sometimes the faintness comes first, and then on recovering the arm is found to be in a state of contraction.

She returned, having had no faint, and the arm a great deal better. She is taking a warm purgative, with serpentaria, valerian and bark.

No. XCVI.

Miss G., tall and fair, Yorkshire, æt. 25. She has a pain of the arm and breast, dull and sharp. What, both? "No, a kind of burning as well as aching." The pain extends round the shoulder and neck. (Patients can never find words expressive of these nervous affections.) The arm to be put into the nose of the vapour-bath and steamed, and the liniment rubbed in. She takes blue pill with belladonna at night. Draught with infusion of cusparia and rhubarb, with carb. ammonia.

No. XCVII.

A. N., æt. 23. Sept. 1824. This young woman was sent by her surgeon to consult Mr Bell for a painful affection, extending from her arm to the shoulder, neck and face; and which has resisted every method of treatment employed for its cure. The skin is also deprived of sensibility from the middle of the fore-arm downwards; the elbow is bent, and she cannot extend the joint. She cannot rotate the arm, and has very little power in moving the fingers.

From the history which she gives of her complaint, it would appear that she injured her wrist a twelvemonth ago by over-straining; and this was followed by inflammation extending to the elbow and shoulder. This was the origin of the elbow-joint being bent as at present. When splints were employed to straighten the arm, they gave rise to so much pain that they had to be given up. She continued to have acute pain in the hand and lower part of the arm, although the inflammation had quite subsided. Three months ago the numbness and insensibility of the hand came on.

The pain which she suffers is incessant, but it is aggravated by touching or moving the arm. It extends from the arm, along the inside principally to the axilla; it then darts along the side of the chest and upwards upon the side of the neck and face. She fears she may lose her right eye, the severity of the pain is so great. She was recommended to become a patient in the hospital, where she remained some months, but without improvement.

No. XCVIII.—*Severe pain extending from the Hand to the Face.*

M. King, æt. 17, while these sheets are preparing for the press, comes recommended by Sir James M'Grigor. She complains of a severe pain in the ball of the thumb, which extends upwards along the arm, as far as to the side of the face, and which has followed a wound in the angle between the thumb and fore-finger. It is fourteen months since she cut herself with the point of a knife: the wound was situated on the palmar side of the first joint; it was followed with considerable hemorrhage, but this was arrested by pressure and a styptic. The wound did not heal for a month. It was attended with severe pain while healing, although there was little inflammation around it. The pain reached upwards towards the elbow. After the wound had been closed, the pain ceased; but it returned a month ago with great severity. On inquiring into the condition of her health before the pain recurred, the mother relates a story of her daughter having been much frightened by an apparition. From this time she became depressed in spirits, and her health affected. The pain commenced gradually without any assignable cause, and became in the course of a short time of the most excruciating kind. It almost made her "lose her mind." The attacks begin with a severe throbbing in the original wound, attended with a sense of burning heat (although the hand is cold). This extends slowly up the arm, then fixes in the shoulder, and affects the teeth of the same side. There is occasionally a swelling of the side of the face, and redness and weeping of the left eye accompanying these attacks. They begin in the evening to be more severe than at other times; yet the suffering continues during the day, and often wakes her at night.

The wound has no redness, and the cicatrix appears perfectly sound, yet it gives her great pain to press it with any force; and she cannot use it for the simplest action without bringing on a severe attack.

Her health has been much affected since the pain began to be so severe: she has no appetite; has nausea.

The following note proves, that the head and spine are peculiarly apt to become the seat of pain, however remote the primary injury:—

"Before the amputation, they attempted to take up the radial artery, and included the radial nerve. This had a sudden effect; the pain darted from the back of the head to the right temple, and made him spring involuntarily to his feet, although he had been lying flat on his back!

"The amputation of the fore-arm was performed; the stump sloughed; after the cicatrization, the extremities of all the nerves were tender.

"This is his present condition; his pain comes in paroxysms affecting the head and neck: they are sometimes attended with momentary darting pains from the face to the back of the head. The spine, too, is affected, the pain in the vertebræ of the neck and back being sometimes so great, that he cannot permit the spines of the vertebræ to be touched. His suffering from the hand is continual, but it is sensibly worse when the stomach is out of order. He is troubled with flatulence and constipation, and has incessant tinnitus aurium in the left ear."

No. XCI.—*Case shewing extreme Morbid Sensibility of the Trunk, &c.*

August 1835. ——— a middle aged gentleman, from the north of Scotland. He complains of an excruciating pain seated in the whole back

On entering the room it was observed that he made use of no preliminary ceremony, but quickly seated himself on the nearest chair; and, after being seated, pressed his body in a somewhat remarkable manner against the back of the chair. He had scarcely sat down, however, or begun to relate the particulars of his case, when he rose, apparently in great suffering, and paced about the room, mentioning at the same time that he obtained relief from the acute pain in his back, sometimes by pushing his back against the wall, or the chair if he were sitting, or by moving actively about. When he proceeded to strip himself for examination, a gentleman present gently raised the edge of a part of his dress to assist him, when the patient suddenly wheeled round, with an expression of excitement and terror, to beg him not to touch his back. It was obvious how the actions of removing each article of his dress were attended with pain, for he was observed first to hesitate, and then to pull them off with a sudden hasty jerk. The pain extended over the whole of his back, and on both sides equally. A gentle touch of the finger upon the skin at once caused a paroxysm, and he writhed and stamped from the intense agony; but when the pressure was applied forcibly, he made no complaint; on the contrary, it has been already stated, that one of his chief means of obtaining relief from the pain was by pressing strongly with his back against his chair, or sometimes by coarse rubbing with the hand. He has found that, next to sitting in the manner described, the pain is made more bearable by keeping in continual motion; hence he cannot remain long at home, but he walks during the greatest part of the day; and he remarks that, if he is met by an acquaintance, who stops to speak to him, the agonizing pain returns.

Shortly before this complaint commenced, which is about four years ago, his strength was much reduced by profuse hæmorrhage from piles, which has been arrested by the piles being removed. He has been compelled to give up attention to his business. Travelling has occasionally been of service to him. His back bears evidence of the severe treatment that has been pursued, on the supposition that the disease arose from inflammation of the spinal marrow. The pain has not been subdued by any of the different modes of treatment that have been tried; but it is, on the contrary, somewhat worse than it was.

I had not the opportunity of pursuing this case, as he was suddenly called home.

Such cases are important, when we find so many patients, particularly young ladies, laid for months in the horizontal posture, on account of morbid sensibility in the spine or back.

On the subject of neuralgic pains, I have not touched on those which, seated in the extremity, have their cause in disease of the trunk of the nerve, or arise from disease involving it, or a tumour or exostosis pressing upon it. The familiar examples are spasm in the leg from pressure of the womb; agonizing pains in the foot from cancerous disease in the pelvis.

No. C.

A case occurred very early in my practice, of unusual interest,—a man died of agonizing burning pain in the sole of his foot, and the poisonous drugs that were administered in the hope of relieving him. Only two days before his death I found a hard tumour like a piece of bone in the ham, and that the pain in the foot proceeded from this. On dissection, I found that the posterior tibial portion of the popliteal nerve was the seat of a soft cancerous mass, which had grown in its substance, and split the fibres of the nerve.

Now, it was recollected that this man, a ship's carpenter, had fallen from the side of a ship in dock, and was caught in his descent on a bolt which projected from the ship's side. He was caught by the ham, and hung by the leg. There appeared every reason to believe that the injury to the popliteal nerve had caused the disease in it, and that the remoteness of the place of pain had drawn the practitioner's attention from the real seat of the disease.

AFFECTIONS OF THE EYE.

No. CI.—*Case of Paralysis of the Voluntary Muscles of the Eye-ball.*

(*Communicated to the Author.*)

"*November* 24. 1825.

"The master of a small trading vessel applied for advice. The most prominent and obvious symptom of the case was *Ptoxis*, or paralysis of the upper eye-lid. Suspecting that there might be a general affection of the third nerve, or motor nerve, I desired him to look to the ground: he attempted it, but was utterly unable to accomplish his intention. He was also told to look upwards, and then inwards: in both which he failed.

"He could close and wink with the eye-lids when we touched the cilia, proving that the *portio dura*, and the branches of the fifth, possessed their sensibility and power.

"Now, forcibly separating the eye-lids, and desiring him to close them, while I still held them open, I could distinctly see the eye-ball turn upwards, which I supposed to indicate that the fourth nerve still influenced the trochlearis muscle.

"He had the power of looking outwards, accomplished by the sixth, which was not included in the paralytic affection. He saw well, save that the fallen lid interfered with vision. He had been troubled with this affection nearly a fortnight, attended with slight headach, and some symptoms of derangement of the stomach and bowels.

"SAMUEL JOHN STRATFORD."

Ptosis is the term applied by surgical writers to the relaxed eye-lid, when the person cannot raise the eye-lid so as to disclose the pupil. We have here nothing to do with those cases, where the inability depends on disease in the eye-lid itself: but it must be acknowledged, that the subject of paralysis of the eye-lid was obscure until these observations were made. We perceive that this ingenious gentleman, when he found that the patient could not raise his upper eye-lid, reflected that this must be from paralysis of the levator palpebræ superioris; that the defect must in all probability be in the third nerve; that if so, the motions of the recti, with the exception of the abducens, must also be imperfect. He found this to be the case. He then reflected that the instinctive turning up of the eye-ball depended on other muscles and on other nerves. He knew that when I had cut the voluntary muscle, the *rectus superior*, although the creature could not turn his eye to objects above, yet the instinctive motion of the eye-ball upwards by the *obliqui* remained. He tried, and found that the involuntary turning motion of the eye-ball was here entire.

We perceive the importance of this observation, since the defect is proved to be in a cerebral nerve, and therefore to imply an affection of the brain, and to threaten apoplexy. It stands contrasted with that inability of closing the eye which results from the affection of another nerve and of a different system, the system of respiratory nerves, which are more subject to derangement than the cerebral nerves, and which offer a less alarming symptom.

It is said by surgical writers, that where there is *ptosis*, the patient, seeing a little under the eye-lid, soon gets into the habit of squinting. Squinting is never a *habit*, the fact being, that the weakness of the *levator* arises from a defect of the nerve common to that muscle, and to all the voluntary muscles of the eye; and hence the involuntary muscles acquire a preponderance, or comparative increase of power, and drag the eye-ball.

Practice or experience points out a distinction between the condition of the patient, when the eye-lid has fallen from paralysis, and when it is spasmodically twitched by the action of the orbicularis. This last is the periodical ptosis; and do we not perceive that the one is the formidable affection of the cerebral nerve, and the other the sympathetic affection of the respiratory nerve?

No. CII.—*Incessant Motion of the Eye.**

This dropping of the upper eye-lid has now become familiar to me.

---

* The incessant lateral motion of the eye-ball is called *nystagmus bulbi* (νυστάζω, to nod or nap); or *hippus* by Galen (ἵππος, a vibratory motion of the eye). Mauchartius (de ulceribus corneæ) describes a continual motion of the pupil, which he calls *hippus pupillæ*.

One gentleman (who no doubt will see this) has returned to me some five or six times in the last ten years, with this very unpleasant symptom. Formerly I successfully treated it by repeating the blue pill for two successive nights, following it with a smart purge of aloes and soap. The last time it yielded to a purgative with a minute dose of croton. The same symptom has occurred in a formidable degree twice in a patient whom I visited with Dr Jones of Manchester Street.

No. CIII.

Whilst writing, there lies in the hospital a patient with fracture of the base of the skull, in whom there is a regular spasmodic motion of the eye-ball, as regular as the motion of a pendulum, from right to left.

No. CIV.

The following note, which I owe to our ingenious house-surgeon, Mr Goss,* refers to a tremulous motion in the muscles of the eye:—

"Joseph Rogers, thirty-five years of age, has lost the right eye, and has had an opacity in the centre of the cornea of the left eye for twenty years. The left eye has a curious semirotatory and involuntary motion, which is constant. The rotatory motion is to the extent of about one-fourth the circumference of the ball. The cornea is nearer the nose than is natural, forming an imperfect squint. He has not the slightest power in arresting this motion; it is that which would be produced by the alternate action of the obliqui antagonizing each other."

I had put my young friends in the hospital upon investigating this case. But being a physician's patient, and they not knowing my wish, he was dismissed. When the pupils brought me to visit this man, they announced it as a case where, notwithstanding the continual motion of the eye, the patient was insensible to that motion, and saw objects naturally and at rest.

No. CV.—*Case communicated by Mr Alexander Shaw.*

Sophia Walker, æt. 17, has an incessant motion in both her eyes. The left eye is shrunk; she lost it during infancy, when she had the small-pox. In the right eye there is a leucomatous spot upon the inner side of the cornea, nearly opposite the pupil, and to this part the iris adheres, but she sees objects distinctly with it. The remarkable circumstance is, that her eyes are not for a moment at rest, and yet this motion does not disturb her vision. There is a constant tremulous motion in them, which her mother says has continued since her infancy; it is not so much upwards and downwards, as in a transverse direction, but it is irregular in this respect. When she was requested to take her book and read, she read with perfect ease, and yet there was no cessation of the motion in her eye. She threaded her needle without any apparent difficulty, and then shewed how she could sew, which was with the usual nimbleness; she gained her living, indeed, by her needle-work. She also looked steadily at various objects in the room, but the motion of her eye continued the same in all these attempts. She was asked to look as far upwards as her eye could be directed, and in the same manner to strain her eye in all the various directions, but by no means could the tremulous motion be arrested. She was not sensible of there being any defect of this kind in her eye, or at least it did not produce any inconvenience; all objects seemed in their natural state either of rest or of motion. When she looked at herself in the glass, she saw her eye rapidly moving.

---

* Now surgeon at Dawlish.

In order to ascertain whether any change took place while the eye-ball was involuntarily rolled upwards, the eye-lids were held apart, and she was told to wink forcibly: the cornea was elevated, so as almost to be hid, and during the time that it remained in that position it was quite fixed and steady. It was next desirable to know whether the eye-ball remained fixed during sleep. When the eye-lids were gently closed, the eye-ball continued in a state of motion, and communicated a very distinct quivering to the eye-lids. This was observed by the mother, and she was then requested to take an opportunity while her daughter was sleeping to remark whether this quivering motion continued the same. Three days afterwards I was informed by the mother that no motion whatever could be observed either in the eye-lids or the eye itself during sleep.

No. CVI.

Note.—A child, about four years old, was brought to the hospital by the mother, who was a patient. The eyes were observed to roll continually in all different directions, and without any correspondence. It appeared, sometimes, that the child merely squinted, but the squint was continually varying; the motion of the eyes was generally in a transverse direction, but occasionally they converged, and then again separated. The child was very short-sighted, and, it was remarked, whenever any object was brought so close as to attract its attention, that the eyes became fixed. This wandering of the eye resembled what is seen in congenital cataract.

No. CVII.

Note.—June 1st.—There is at present in the hospital a young woman who has had cataracts in both her eyes from infancy. She has a constant rolling of the eye, a vacillating motion, like the balance-wheel of a watch. She sees a little, and can distinguish a person in the ward; but notwithstanding the motion of the eyes, the object she distinguishes is at rest.

June 24th.—The opaque lens of the left eye was pierced and disturbed with the needle, and the capsule burst or torn. This operation after three weeks was a second time performed: the vision improved, and the eye became steadier. Some time after I couched the other eye; the vision is perfect in that which was first operated upon, and is fast improving in the second. The motions of the eyes have much diminished.

No. CVIII.—*Case communicated by Mr North.*

Francis Robbins, æt. 19, has been short-sighted from his infancy. The structure of the eyes appears perfectly natural. The pupils are less contracted by the application of a strong light than is usual. I have seen him frequently during the last six or seven years, and have always observed that the eye-balls are in constant motion, not upwards and downwards, but laterally. He is of a very nervous temperament, and upon the slightest excitement this motion of the eyes is considerably increased, and no effort to look steadily at an object placed before him has any effect in restraining it. His vision does not deceive him as to the state of things he looks at: he is sensible when objects are perfectly at rest, and perceives immediately the true direction of the slightest motion which is given to them: he can read music with facility, and plays accurately from the notes rapid passages on the violin. If he is surrounded by many moving objects his vision becomes confused, and he forms an erroneous judgment as to their distance from each other, and from himself. Thus, in the morning early, before the streets are crowded, he drives a carriage and pair of horses with safety and dexterity, but he cannot do this in the middle of the day, when, to use his own expression, "he gets flustered," and is afraid of meeting with accidents.

¶ This motion of the eye, without a corresponding idea of change in the position of the object, is certainly a very curious fact; yet it admits of explanation, if the statement which is made in the text be correct. We observed that vision is a compound operation, that the impression upon the retina is combined with a certain effort of volition, and that this volition, directed to the muscles of the eye, is necessary to the idea of motion or place of the object. If a motion of the eye takes place without volition, there is a want of that essential circumstance which indicates place or motion. These patients, therefore, having the motion of the eye from a different cause than volition, although the impression of the object moved upon the field of the retina, had simply the sensation on the retina, without the idea of motion, because there was no muscular effort.

Of the Eye-lids; as indicating different Affections of the Nerves.
(*A communication of the Author to the Medical Gazette.*)

My attention having been drawn to the actions of the muscles of the eye, I have persuaded myself that there is a strict correspondence between the retina, as the organ of vision, and the surrounding muscles. We observe that, when the retina is excited by vision, there is an attendant excitement of the recti, or voluntary muscles of the eye; and that when vision is not exercised, the eye then becomes passive, and is drawn upwards by the preponderating influence of the obliqui: that, consequently, there is an established relation between the falling of the eye-lid and the revolving of the cornea upwards.

It did not occur to me that any thing farther could be done in the way of experiment, than what is offered in the *Philosophical Transactions*, June 1823; and I conclude that we must wait for the opportunity of observation in the human eye, to perfect our knowledge of this subject. It is with this view that I present you with the following cases, to which my attention is at this moment directed.

The condition of the eye-lid and eye-ball, when carefully observed, appears to me to give the symptoms of very different affections of the nervous system. Putting aside the affections which come under the head of strabismus, we have, in the first place, the eye-lid fallen, from disease of the eye-lid itself, independent of nervous disorder; secondly, the eye-lid permanently elevated, and the cornea exposed (*Lagothalmos: vue de lièvre*), indicating defect in the office of the portio dura; thirdly, incapacity to raise the eye-lid, attended with total insensibility of the surface of the eye and side of the face, with the power of forcibly closing the eyes still retained: indicating disorder of the nerves within the orbit, probably pressure between the origin and distribution of the nerves, the portio dura being free from disease; fourthly, a motion in the eye-ball itself rapidly to and fro (*Nystagmus bulbi*), independent of any affection of the eye-lid; fifthly, we have the eye-lid depressed, and the motion of the eye-ball remaining; sixthly, we have the eye-lid depressed, and, at the same time, the cornea elevated.

It is to these two latter cases that I have to request the attention of your readers: in the first place, as they imply very different conditions of the nervous system; and, being attended with blindness, may be confounded with affections of the optic nerve or retina.

No. CIX.—*Case of Periodical Blindness, from a cause not hitherto observed.*

The subject of this case is a young lady, twenty-four years of age, of a delicate frame, with great intelligence and expression; accomplished, and, as ladies are, studious. She was in the habit of drawing a great deal, and had painted a miniature a short time before the symptoms I have to describe commenced. In giving the case, I am assisted by the letter of her physician, which she presented to me, and which shews that he has studied the symptoms, having that interest in the case which is so naturally excited in a benevolent mind.

In August 1826 she began to have headachs, which, however, had not a common character: the pain extended down the side of her face to the angle of the jaw, and then backwards into the ear, with a sensation of tightness in the skin of the forehead; and this pain she had first on one and then on the other side of her face. These pains appeared to her physician to be "connected with considerable disorder of her stomach and alimentary canal, increased, if not produced, by too sedentary a habit, and application to drawing. After a dose of calomel and opium, she took, in succession, the sulphate of quinine, the extract of henbane, and the liquor arsenicalis. She had also the blue pill, until her mouth became a little sore."

The pain had ceased, and a "heavy stupidness," to use her own expression, prevailed for a few days, when one day, in reading, she found that she could not see the letters,—they were thrown together and confounded. This obscurity of vision was attended with a fluttering in the eyes, which seemed to her alternately to open and shut with great rapidity: by turning away from her book and attending to other things, she could read for some time when she again looked upon the page. The application of leeches relieved these symptoms for a day or two; but the relief was temporary, and she gradually lost the power of directing her eyes. From the beginning of this affection of the eyes, the pain ceased in the head. This "actual blindness came on periodically. It began about ten o'clock in the morning, and ceased about four; and, during the blindness, there was constantly presented a most quick motion of the eye-lids and eye-balls; and during the whole of these attacks, she lost all control over the muscles of the eye-lids and eye-balls. She could partly see, or at least distinguish light from darkness." Her vision was occasionally restored: at one time her medical man having made his visit, he was called back as he was stepping into his carriage, she having at that moment entirely recovered her sight. Her blindness has of late been permanent. Her physician looks upon these symptoms as connected with nervous irritability, and different from genuine amaurosis arising from disease of the optic nerve or retina. I should have stated that the solution of belladonna was applied to the eye-lids, by which her medical attendants satisfied themselves that there was no cataract. They next ventured upon the galvanic battery; and were encouraged to proceed in consequence of her being able to see almost on the first shock, which was given across the eyes. She found her way out of the room without assistance, and could distinguish the colour of the ladies' dresses who accompanied her in the carriage. After this, although a spark of light was excited at each shock of the battery, her sight did not improve; and she even lost that degree of vision which she had enjoyed in the morning and the evening.

This young lady has a pleasant, intelligent manner: but I observed to her, that she conversed with her ears! on which she said, "Oh dear, am I already so bad as that?" understanding perfectly what I meant,—that the direction of her countenance to those who addressed her was like that of a blind person. This expresses a fact, at the same time that it may shew the acuteness of her understanding. Her eye-lids are dropped over the eye, but not with the character of a paralysis: they are in continual motion while she speaks, being raised and depressed for about the twelfth of an inch; and never so far raised as to expose the pupils; the eye-brows are raised by an ineffectual attempt to open the eye-lids. She can close the eyes and wink, powerfully compressing them. The tears flows plentifully. There is not the slightest degree of inflammation in the eyes. The concealment of the pupils is not altogether owing to the dropping of the eye-lids, but to the eye-balls being at the same time rolled upwards: she has an equal inability of raising the eye-lids and of depressing the eye-balls. If there be a difficulty of understanding this description, I would say that there is continually in this young lady that condition of the eye and eye-lids which the surgeon sees when he is about to examine the eye, or perform an operation on it: the cornea is turned up, whilst the eye-lid is forcibly drawn down—such is exactly the condition of this young lady's eyes.

The first thing I did was to stretch the eye-lids over the eye-ball, and keeping her face directed to the window, I inquired, "Do you see red light?" No," she said, "but I see bright yellow light." I had forgot that when we look through the eye-lids the light is red, but if we stretch the eye-lids, so as to undo the furrows, we see a brighter yellow light. This fact was sufficient to shew me that the defect of vision was not in the retina, but arose from a deranged action and want of consent in the muscles of the eye. I next inclined her face downwards, and forcibly raising the upper eye-lid, I disclosed a small part of the pupil, the eye-ball being powerfully rolled upwards: before I did this I said, "Let me try if you cannot see your surgeon;" and as soon as the pupil was disclosed, she said, laughing, "I see he has on spectacles." I next asked her to turn her eyes in different directions; she could turn them to the right and to the left, but she met with an uncontrollable opposition in rolling them downwards. To these facts let me only add this consideration: we might imagine that when the pupil is disclosed, however little, she ought to see distinctly; but this cannot be, for the light that then enters, enters obliquely, not in the line of the axis, and consequently the impression is not made on the more sensitive central part of the retina. If we are looking to the side of a room which is hung round about with pictures, we faintly distinguish the frames of the pictures lateral to our position, the light from these objects falling upon a part of the retina, which is less sensible. It is not, therefore, any morbid insensibility of the retina which renders this young lady blind, but the fact that she cannot even for a moment direct her eye to the object, and consequently cannot receive the impression in the central portion of the retina, which is alone capable of distinct vision.

I expressed my opinion that this was an instance of that irregular muscular action which depends on some remote irritation, and is not referable to organic disease, either of the brain or nerves, and that I saw no reason why we should not hope for sudden restoration of sight.

Dec. 24th.—On conversing with the family again, I find that the above statement is correct. She, however adds, " I wonder, considering the many questions you put to me yesterday, that I forgot a circumstance which is, perhaps, important; that I have pain extending round the head as if it were bound by a hoop. This is not continual, but is excited by the motion of a carriage or by noise. I have also," said she, " a whizzing noise in my ears, especially when I awake in the morning."

My first idea was to excite the viscera of the abdomen by emetics, and to follow these up by opiates.

January 3d.—During the operation of the first emetic her eyes opened, and she saw for a short time. On the second operation, her eyes remained open for ten minutes. The opiates being then administered, on the first morning when she awoke she saw perfectly, but after a short interval she was again blind. This morning she met me with a still better account,—that she saw during all the time of breakfast, and had played a new song from the book. But what was most agreeable took place during my visit, for whilst I was writing my prescription, she called with interest to me to look at her! and, to my surprise, her eyes were open and steadily fixed upon me, her countenance was wholly changed, and I need not say improved; I thought that her sister had slipped into her seat. Her sight continued perfect whilst I remained in the house.

January 27th.—This happened twice afterwards, her eyes remaining open for the space of an hour. This was not altogether chance, but depended upon the high excitement of her mind whilst I conversed with her, she having the greatest confidence in my power to relieve her. I increased the dose of opium, by giving her a pill at night and a draught of thirty-five drops of laudanum in the morning. It had the effect of opening her eyes for a longer period, that is, for an hour and a half or two hours; but it became oppressive to her, and I accordingly left it off. Fearing, during our bad weather, that the opiates and the confinement might affect her health, I gave her bark, and substituted the local application of opium for the opiate draughts, and with the most remarkable effect. A blister was applied to the temple, and a lotion of opium ordered to wash it with. The effect was almost immediate, but still it was temporary; however, with this advantage, that she could see when she chose, for by going up and bathing her temples with the simple opium lotion, she could come down stairs seeing perfectly for twenty minutes or half an hour.

February 2d.—To-day I had a pleasant scene with this young lady, for she met me, saying, with her usual cheerful manner, " I have got a way of restoring my sight as well as you, for there is a part of my temple which, when I press with the point of my finger, my eye-lids are instantly opened." She put this in practice. Feeling for the little pit before her ear, and above the jugum, and pressing pretty firmly there, the eye-lids went up with a rapidity and effect as if she had touched the spring of a Venetian blind, and they remained open as long as she kept her finger there. She proceeded to inform me that she had found this accidentally, and that when she pressed both temples the relief was more complete, but that pressing on one side was sufficient to open both eyes; of which she made demonstration to me. I conceived at first that she had pressed upon some branch of the fifth nerve, for I could conceive nothing more likely to produce an influence upon the nervous system of the head; but when I pressed upon the divisions of the fifth pair on the forehead, and on the jaw-bones, it had no effect. It next occurred to me that it was by pressing on the artery; to ascertain which, I stopped the pulsation of the carotid by pressing in the neck. Whilst feeling for this, she said, " I know that there is a part of the neck which has the same effect, but I cannot find it again." When I put the point of my thumb under the angle of the jaw, and pressed the carotid against the vertebræ, the effect was perfect. I thought, for the moment, the effect might be produced by pressure on the ganglion of the sympathetic, caused by some influence of the circulation over the nervous system of the head.

Some days afterwards, at my visit, she told me, that on pressing at the pit of the stomach the same effect was produced as on pressing the temple. This I found to be the case; for, on pressing down the cartilages over the left hypochondriac region, so as to press the cardiac portion of the stomach, the eye opened, and it remained open whilst I pressed. Being now more and more convinced that this affection of the eye depended on some very slight irritation, and she being in high spirits, I satisfied myself with putting her on the plan of tonics, such as steel, and a mild purgative, and permitted her to go into company. She enjoyed one night at the play, but returned from it with a severe headach, fell into bad health and bad spirits; no pinching any where could raise the eye-lids, and we were all full of disappointment. Dr Babbington was called into consultation: he prescribed pills of the cuprum ammoniatum. After eight days, her friends being alarmed with the increasing weakness and want of appetite, I once more changed the treatment to a draught of quinine and a pill of calomel, with the compound aloëtic pill. She is at this moment obviously benefited by this: she has recovered her spirits, and, by opening the eye-lids of one eye, the other eye is disclosed also; and in a moderate degree she can enjoy her reading and drawing.

I told this lady, on leaving town, that she must not be surprized if some day it should happen that the eye-lids should open and the teeth close, which in a short time after took place. And to this locking of the jaws she was subject from time to time. She now enjoys perfect health, and has no nervous symptoms.

I remember no other instance like this, except one in the Medical Museum, in which the patient, a female, saw perfectly well in the morning till ten o'clock. When it "turned of ten" it seemed to her as if her eyes were covered with a cloud: and this darkening of her sight was preceded by convulsive motions in the integuments of her forehead. She was relieved by opium, but relapsed in consequence of some misfortune, attended with low spirits.

We see how apt the practitioner would be to suppose this some singular affection of the optic nerve: a species of amaurosis contrasted with nyctolopia, since it seems inexplicable at first that the patient should see in the morning, become blind at ten o'clock, and remain so till four. There is a reflection, however, calculated to give comfort—as the symptoms vary, so must the cause also vary: and this proves that it is not organic; for if the cause were organic derangement, the symptoms would be permanent.

No. CX.—*Blindness from dropping of the Eye-lid; and imperfect motion in the Eye-ball.*

A boy, about eleven years of age, was brought to me a twelvemonth ago. He was of a scrofulous habit, had a pale and sickly look, and had disease in his knee-joint. When the complaint which I have to describe commenced, it was in this manner. He came from school, and said to his mother, "The boys tell me I squint; is that true?" adding, "I saw two masters in the school, and two of every thing."

The boy is intelligent, docile, and (his mother says) acute. His countenance is very peculiar, from his eye-lids having fallen and his eyebrows being elevated and arched. He cannot see without throwing back his head and looking under his eye-lids, in the manner of a person who is trying to see from under a green shade. The reason of this is, that if he keeps his head in the usual position, he can only see the ground at his feet, but by throwing back his head, without changing the relative position, either of his eyes or eye-lids, he is then enabled to see any thing on the same level with himself. He has a little more power over the left eye-lid than the right, but it is clear that he has not complete power over either of them. He raises the left eye-lid with his finger, and then says he sees his mother distinctly. Although he cannot raise the eye-lids, he can shut them firmly; winking if the eye be irritated.

In the attempt to open the eyes he wrinkles the forehead, and arches the eye-brows, but only draws the skin of the eye-lids smooth, without raising the margins of them.

His mother says, that when he saw double, she observed his eyes were both turned to the right side; objects, however, do not now appear double. In the beginning, as now, there was a twitching of the face, and a drawing of the mouth a very little to the left side.

On attending more particularly to the motions of the eye-balls, the left eye is observed to move in a lively manner, but perhaps not to the full extent, and the right is more fixed; but when I close the left, and lift the eye-lids of the right, and place my face opposite to the pupil of the right eye, he sees me perfectly. Although he sees the light when I open either the right or the left eye, yet the iris of the left only is moveable. The pupil of the right is dilated.

This boy's health declined in the course of a few months. He first complained of pain in his right arm, and across his nails. He became subject to headachs and flushing of the face; he had a wasting of the muscles of the thumb, and soon after an obvious withering of the whole arm. Before his death he became quite paralytic, and finally the paralysis extended over his body generally. Yet it was remarkable, that when he slept the left arm was always elevated above his head, and although his mother put it down twenty times under the clothes, in a very short time she found it again stretched above his head. He remained sensible until two days before his death. He said he was quite willing to die; and that, as his surgeon had paid him greater attention than any person during his whole life, he hoped his mother would let him examine his body if he desired it.

The dissection of the brain exhibited all the common appearances of acute hydrocephalus: in the ventricles there were about ten ounces of fluid; the substance of the brain was exceedingly soft, so that it tore, and became flocculent in the water of the ventricles. On the base of the brain coagulable lymph was exuded, and it bound the roots of all the nerves, from the olfactory down to the ninth. The fifth was the most entire; the third of the right side was hardly discoverable amongst the coagulable lymph, from its having degenerated and acquired transparency. There were several scrofulous tubercles in different parts of the cerebellum and nodus cerebri.

Although there be a certain resemblance in the symptoms of these two cases, yet a careful observer will distinguish a nervous affection, proceeding from organic injury, in the one case, from that which is, in the other, purely spasmodic. In the boy, there was no part of the functions of the eye and eye-lids perfect but that which belonged to the portio dura of the seventh pair of nerves, that nerve which takes its course circuitously to the eye-lids by the ear, and the side of the face; on the contrary, the functions of those nerves which came through the bottom of the orbit were more or less injured. I would be inclined to attribute the first train of symptoms to the condition of the base of the brain; no doubt the state of the boy ultimately was referable to the hydrocephalic condition of the brain.

And now let me mark the difference of the symptoms in the lady's case. The disorder did not come on gradually, nor was it permanent at first; it came on like a sudden spasm, and as suddenly disappeared. We have next to observe that it is a morbid condition, mimicking a natural state of the eye; for the action of the eye is here the same as when a candle is held to a sleepy eye; it is the condition of the muscles of the eye, when the organ is excessively irritated. It may, therefore, be described as a natural action become permanent; such a condition, then, as is consistent with the idea of irritation upon the nervous system: it does not imply any actual defect, as in the other instance, where the eye-lid, instead of being tremblingly alive, hung motionless, and the eye-ball, instead of being turned up with a strength that implies spasm, was simply limited in its play, or altogether motionless.

No. CXI.—*Inability to close the Eye-lids.*

In the preceding part of the paper I have mentioned the condition of the eye, in which it appears ever watchful; the eye-lids do not close upon it even in sleep, and it has been called *oculus leporinus*, from the vulgar notion that the hare sleeps with its eyes open. I have a young lady now under my care, in whom this condition of the eye was presented, in the early stage of the complaint, and it still in some degree remains. A very few years ago it would have appeared to me of the utmost consequence for understanding the functions of the portio dura and the fifth pair of nerves; even now its interest is only diminished to me from its frequent occurrence.

This lady, 22 years of age, was attacked six years ago with scarlet fever and sore throat. Inflammation appears to have been communicated through the Eustachian tubes to the interior of the temporal bones. On the left side, the inflammation went on to suppuration: the mastoid process became carious, and portions of bone were discharged through an ulcer behind the ear. A small bone, the form of which she cannot describe, was discharged also from the tube of the ear. During the progress of this inflammation she never experienced any diminution of sensibility in the face; but a very unpleasant consequence attended this disease of the temporal bone, she became paralytic on all the left side of the face. During the violence of the attack she could not close the left eye. At this period, too, she felt pain in the collar-bone of the same side, and such a degree of difficulty of moving the shoulder-joint, that she describes it by saying it was like a rusty hinge. At present she is dull of hearing in both ears, more particularly in the left: her face is a little twisted to the right side, which becomes quite a distortion when she speaks, and especially when she smiles. The eye-lids of the left eye have recovered in a considerable degree, but still she cannot bring the margins of the eye-lids close together, and in attempting to shut them the white part of the eye-ball is seen, as the cornea is turned up.

In this case all my efforts are directed to relieve the scrofulous action which has been set up in the tympanum. On the second visit I found that the use of stimulating fomentations to the ear, liniments behind the ear, and warm gargles, had the effect of removing the remaining paralysis of the eye-lids.

This case is important, 1st, as shewing the office of the portio dura of the seventh pair of nerves; from its being affected in its course through the temporal bone, and depriving the corresponding side of the face of motion, without in any degree depriving it of sensation: 2dly, we see how the inflammation has been propagated from the throat into both ears; and we cannot but reflect on the unhappy consequences which would have resulted had the inflammation in the right ear gone on to suppuration; for then the muscular power of the lips, cheeks, and eye-lids would have been lost on both sides, and the consequences need not be described:* 3dly, we are directed by the affection of the nerves to the condition of the temporal bone; and it cannot escape observation that the temporal bone is a bone of the cranium, in contact with the brain; and there is danger of that affection of the brain which by the old pathologists was called vomica cerebri. The circumstances of pain and debility in the arm during the violence of the inflammation sufficiently point out the danger of her condition at that time, and that it should still be our principal object to prevent any accession of inflammation in the temporal bone, and to preserve the discharge free.

No. CXII.—*Case illustrative of the action of the Levator Palpebræ Superioris.*

I am tempted to describe the condition of a patient now under my care, because it exhibits a succession of those phenomena which we seek to explain. He presented himself to me in the hospital with a distinct squint, the left eye being distorted from the object. On the eye-lid of the right eye there was a deep venereal ulcer: the man was in danger of losing this eye, and required prompt assistance; but before he could be brought under the influence of mercury, the inflamed sore became deeper and the cornea opaque. The superior rectus muscle being, as I suppose, injured by the increasing depth of the sore, the pupil became permanently depressed. The sight of the right eye being now lost, the left eye came into use; it was directed with precision to objects, he had no difficulty in using it, and it daily became stronger.

---

* See the case of the patient who was in the Hotel Dieu, under M. Dupuytren.

After a few weeks, medicine having had its influence, the sore on the upper eye-lid of the right eye healed, the inflammation and opacity of the eye gradually diminished, the light became again visible to him; first it was yellow, and then a deep purple. And now the muscles resumed their influence, and the eye was restored to parallel motion with the other, so as considerably to embarrass the vision. But the inflammation of the upper eye-lid had been so great as to diminish its mobility; and what appeared most extraordinary, the lower eye-lid assumed the office of the upper one, and a very unusual degree of motion was remarked in it. It was depressed when he attempted to open the eye, and elevated and drawn towards the nose when he closed the eye. The upper eye-lid was not only stiff, but diminished in breadth; so that notwithstanding the remarkable elevation of the lower eye-lid, their margins could not be brought together, and we could perceive the motion of the eye-ball; in his attempt to close the eye we constantly saw the pupil elevated, and the white part of the eye exposed.

I shall now attempt the explanation of these phenomena.

The impression upon the left eye had been weak from infancy, and the retina being unexercised, the recti, or voluntary muscles, wanted their excitement, and were deficient in activity; the involuntary muscles therefore prevailed, and the pupil was turned upwards and inwards, and consequently removed from the axis of the other eye. But when that other eye became obscured, the left eye being the only inlet to sensation, the attention became directed to the impression on the retina, the voluntary muscles were excited to activity, and they brought the eye to bear upon objects. This eye improved daily, because the natural exercise of a part is its stimulus to perfection, both in function and in growth. When the right eye became transparent, and the light was admitted, the voluntary muscles of that eye partook of their natural stimulus, and commenced that effort in search of the object, which in the course of a few days brought the eye to its proper axis, and both eyes to parallelism.

The next thing that attracts our attention in this short narrative is the revolving of the eye-ball. It has been explained in a former part of the work, that when the eye-lids are shut, the recti, or voluntary muscles, resign their office, the inferior oblique muscle gains power, and the eye-ball traverses so as to raise the pupil. It will not have escaped observation, that the pupil of the eye was depressed, and could not be elevated by a voluntary act for the purpose of vision, owing, as we have supposed, to the injury of the rectus attollens, at the same time that it was thus raised involuntarily, in the attempt to shut the eye; a proof that this insensible motion is performed by the lower oblique muscle, and not by the superior rectus muscle.

The circumstance of the lower eye-lid assuming the functions of the upper one, and moving like the lower eye-lid of a bird, reminds me of an omission in the account of authors. They have sought for a depressor of the inferior eye-lid, which has no existence, and is quite unnecessary; for the motion of the *M. attollens palpebræ superioris* opens wide the eye-lids, and depresses the lower eye-lid, at the same time that it elevates the upper eye-lid. If we put the finger on the lower eye-lid when the eye is shut, and then open the eye, we shall feel that during this action the eye-ball is pushed outwards; and we may observe that the lower eye-lid is so adapted as to slip off the convex surface of the ball, and is consequently depressed. The reason of this is, that the muscle which raises the upper eye-lid passes over a considerable part of the upper and back part of the eye-ball, and the origin and insertion of the muscle being under the highest convexity of the ball, that body must be pressed forwards in proportion to the resistance of the upper eye-lid to rise. In the preceding case the upper eye-lid being stiff and unyielding, both the origin and the insertion of the *elevator palpebræ* became fixed points; consequently the action of the muscle fell entirely on the eye-ball itself, whereby it was forced downwards and forwards in an unusual manner, and so depressed the lower eye-lid to an unusual degree. Thus the muscle became a *depressor* of the inferior eye-lid, instead of an *elevator* of the upper eye-lid! The motion of elevation in the lower eye-lid was of course performed by an increased action of the lower portion of the *orbicularis palpebrarum.*

No. CXIII.—*Extract from Mr Shaw's Paper on Partial Paralysis, in the Medico-Chirurgical Transactions.*

"A good example of complete paralysis of the levator palpebræ, and of loss of power in the pupil, without any affection of the retina, occurred last winter; and I was fortunate enough to have an opportunity of examining the body after death. A young woman had a fungous tumour under the jaw; the cheek of the same side was paralytic: the upper eye-lid of the same side had fallen; but when the eye-lid was raised, the patient could see distinctly, although the pupil was fully dilated and immoveable. Upon dissection, it was found that the tumour had extended into the lateral part of the orbit; the fourth nerve ran over the tumour, the third was in the substance of it, but the ophthalmic division of the fifth pair was the nerve most destroyed; the sixth was partially affected. The tumour did not reach as far as the optic nerve. Since all the nerves of the orbit, except the optic, were included in the disease, we cannot draw any further conclusion from this case, than that the motions of the iris do not altogether depend upon the state of the optic nerve. The voluntary power which some individuals possess over the motions of the iris will perhaps be considered as in some degree supporting the view which I have taken. The members of the Society are, no doubt, aware, that one of their most distinguished associates has this voluntary power over the motion of his iris. Upon an occasion in which the gentleman I allude to was so kind as to shew me to what an extent he could exercise this power, I thought I could perceive that the exertion which attended the attempt had some effect upon the motions of the upper eye-lid."

No. CXIV.—*Uncommon Affection of the Portio Dura.*

This is an officer of the Bengal establishment. His face is singularly contracted. There is a violent action of all the muscles on the right side of the face; the eye forcibly shut; the forehead contracted; the mouth drawn and pinched up. On the *left* side the eye is forced out with an extraordinary character of intense scrutiny.

The sensibility of the face is natural. This spasm comes on occasionally. It is disappearing since he came into the room. It attacks him when speaking to a lady. He has nothing of it in leading his men into action.

He has received fifteen wounds. In 1808 he fell from his horse; there remains in consequence of this a swelling on the left side of the parietal bone. A year after this he had a coup de soleil while on parade, and was carried off insensible; and after this he lost the use of his limbs for six weeks. He has false teeth on the right side, and suffers a shooting pain in the socket of the eye-tooth, which was extracted. He cannot see objects whose rays fall on the left side of the left eye; so that his good eye is closed by spasm of the eye-lids, and the left, which is defective, is that which is open.

No. CXV.

Mrs F., an old lady, mother of a large family. She has occasional pains in the top of the head; first it is cold, and then it burns: but her chief complaint is of twitching of the left eye-lid and left side of the face. There is no pain of the face, but only aching when the spasms have subsided. When she enters a house these vibratory motions of the eyelids commence; they go off on going out.

She requires a warm purgative draught, and a good family pill; fomentation to the side of the head, or, as that may give her cold, a liniment with camphor and æther to touch the upper eye-lid with.

The following shews the dependence of the action of the muscles of the eye on the sensibility of the retina.

No. CXVI.—*Case of Strabismus with Affection of the Eye-lid.*

Cromer, March 11. 1829.

"Sir,—I feel much obliged by the favour of the letters I received from you; beneath you will see the remarks I have been able to make on the case, and I shall always be happy to contribute such others as it may be in my power to supply. I am, Sir, yours most respectfully,

"C. S. Earle.

"In Wortley, the falling of the eye-lid is not the whole cause of one eye only being used at one time. The foci of the eyes are not alike, the focus of the right (viz. the sound eye) being the common distance, while that of the left is several inches more. When the right eye is directed to any object, the left eye-lid falls, but it can be elevated at will, though not completely so; when it is thus elevated the eye-ball is turned upwards and outwards, and is then not under the influence of the voluntary muscles; but if the right eye-lid is closed, the left eye-lid can not only be elevated, but the eye-ball will resume its proper position; it cannot, however, be turned in the slightest degree further towards the nose; it can be directed downwards, but then the eye-lid follows it, and half closes it; when an effort is made to move it upwards, it inclines slightly outwards at the same time; it perfectly retains the power of being directed outwards.

"The right eye can be turned in any direction by the voluntary muscles.

"When he looks at an object with the left eye he drops the right eye-lid, but after a short time he can elevate it again, without altering the position of the left eye; the right eye, however, will be found precisely in the same state as the left is in, when the right eye is used (viz. turned upwards and outwards, and not under the influence of the voluntary muscles until the left eye is either closed or directed from the object).

"If the finger is applied to the left eye-lid while it is closed, and an effort is made to shut the right eye, the eye-ball can be distinctly felt rolling upwards and outwards.

"He is not troubled with seeing red or yellow light through the closed eye-lid.

"The power of sensation, and also of expression (except so far as I have noticed), is perfect on each side of the face."

No. CXVII.

Mrs S., aged 58. She squints. Has double vision. Complains of violent darting pains; "pulling or tearing her limbs as by the forcing in of a blunt instrument." It comes in paroxysms, and continues for a night and the best part of a day; sometimes only an hour; always in the limbs, unless when there is a sudden plunge across the chest. It has been coming on for three years.

The bowels are confined and very irregular. Slime discharged; the pain much increased by the retention of this slime. It is like the white of an egg—stringy—the smell unnatural and offensive. She has a rising in the throat; confusion of head.

Her complaint commenced at a time when she suffered great distress of mind, and was reduced by uterine evacuation.

No. CXVIII.—*Affection of the Eyes.*

W——. Four years ago he was seized with a sort of nervous attack, a mist coming over his eyes, and a sensation which he calls "pinching" in different parts of his body and lower extremities. An abscess formed on the forehead; there is a lump there now. Improved under Plummer's pill and sarsaparilla. Again became worse. Went to Mr Guthrie, who treated him by cupping and emetics.

He complains at present of severe headach, chiefly during the day, being relieved at night, and double vision. On attentively observing the eyes, I see the defect is in the abductor of the right eye. It wants power after it has contracted to a certain extent. So when he looks to the left side he sees objects single; but on turning the eyes to the right, the object becomes double, and they seem to separate more and more as he looks round in that direction; both objects are equally distinct.

This is an affection of the abducens, which I attribute to its close relation to the sympathetic nerve.

No. CXIX.

3d May. This young lady has a singular manner. I find it proceeds from an affection of her right eye. The eye-ball does not traverse unless she at the same time looks down. When she looks at any thing on a level with her eyes she sees double, and squints; consequently she holds up her chin and throws back her head in looking at you, which gives her a lackadaysical appearance. She has the tenderness of the spine, which is so apt to deceive; pain in the loins; pain on pressing the spines of the vertebræ. I find she has the same susceptibility on the ribs, legs, and arms.

No. CXX.

Patient with Mr M'Clure. B. H. from Brazils. As he looks to me he sees to my right another figure, with all the dimensions increased, "two feet taller and broader." With the left eye he distinguishes colour better than with the right; the colours are much brighter, yet when walking he must shut the left eye. "As the images approach they assimilate in size." It is not on looking to one side that he sees a double object; the defect continues as he looks in the whole circle. The defect is of three years standing. He went to Dr Brandreth of Liverpool.

No. CXXI.—*On Squinting.*

This is a subject which remains unsatisfactory. A passage in the case of Windsor throws some light upon it. It was observed that, when the eye first became stationary, the cornea was directed outwards, but subsequently it was brought back to its natural position in the centre of the orbit. This circumstance is to be accounted for by the tumour extending first to the third or common motor nerve, and finally to the sixth or abducens nerve. The abductor muscle, at first, retained its power by having a distinct nerve from the other muscles of the orbit, and turned the eye outwards; but it became at length powerless from its nerve being involved in the disease, and the eye was accordingly restored to the middle of the orbit. Whilst the abducens nerve was free, a squint was produced by the prevalence of the abductor muscle; and when the tumour extended to the sixth nerve, the squint was removed. Here we see the effect of a predominating power residing in the sixth nerve; but it is the reverse of this condition to which I request the reader's attention.

I have had in the present season several instances of partial squinting, and of one of these I made the following note: "When this lady looks straight forwards or towards the right, her eyes move parallel and with just consent. But when she looks to the left, she sees double; and the more she directs her eyes to the left side the further apart the two images appear. This is attended with a distressing fulness in the head with pulsation, and a sound as when a shell is put to the ear, but appearing to be in the bones of the head."

This affection proceeds from a partial defect in the abductor muscle of the left eye. It cannot act in its greater degree of contraction. So long as the eyes are directed to the right, the muscle being relaxed, it has the power of accommodation to the other muscles; but when it has to contract, on turning the eyes to the left side of the body, it betrays its weakness, and the eyes no longer move in an axis parallel to each other.

It must have been observed that by far the most frequent direction of the eye in squinting is inwards; so that there can be no doubt that the weakness of the muscles is most frequently exhibited in the abductor.

I have noticed in children, that when they have been permitted to gorge themselves at meals, a squint has been produced, which was at first temporary, and only observed on these occasions of distended stomach; but I have seen such children grow up with a confirmed squint. It appears, therefore, to be an allowable question, Is there any thing in the nervous relations of the abducens muscle which should make it more immediately subject to be disordered in its action from abdominal influence? Now the peculiarity is so very remarkable in the connection which the sixth nerve, or abducens, has with the sympathetic system of nerves, that I confess I think we may here detect the cause of the muscle which it supplies being so readily affected from visceral derangement.

Such may be the explanation of the eye becoming in the first place a little distorted. It is well known that when the light from an object falls on any other part of the retina but that which is opposite the axis, the impression is weak: in this person, therefore, who has a slight distortion of the eyes, the image will be faintly seen in the one which is affected. It is also admitted that weak impressions on our eye become very soon neglected altogether: and it is a matter proved, that when the sensation on the eye is neglected, the recti muscles resign much of their power, and suffer the eye to be rolled up involuntarily. This will explain why the eye should be turned upwards as well as inwards, in the most frequent cases of squinting.

Such a course of reasoning authorizes these conclusions in explanation of squinting: 1st, It proceeds originally from a disorder of the sixth nerve. 2dly, The disorder of the nerve, by debilitating the abducens muscle, gives a preponderance to the other muscles which draw the pupil towards the nose. 3dly, The eye becoming distorted, the images of objects fall upon that part of the retina which is less sensible than the central spot, and the impressions on the affected eye no longer bear a correspondence with those on the sound eye; and the recti muscles are not sufficiently excited into action. 4thly, The effect of deficient excitement of the straight muscles of one eye is to give a preponderating power to the obliqui, so as to cause the eye to be rolled upwards; and the consequence of this disposition of the eye to be revolved upwards, and of the weakness of the abducens muscle conjointly, is, that the eye which squints is directed towards the inner canthus, and a little upwards. This state of the eye in squinting is by far the most frequent.

No. CXXII.—*Affections of the Tongue and Mouth, &c.*

"*July* 21. 1825.

" SIR,—I shall feel obliged by your answering this letter at your earliest convenience; * * * *

* * * *

" In consequence of your important discoveries relative to the nerves, I am particularly desirous to have your opinion on the following case. The invalid is an unmarried lady, nearly seventy years of age, who has enjoyed uninterrupted good health up to the present illness. She has had occasional short attacks of gouty inflammation in both feet, and also in the knees, of very short duration. From the first of her complaining to the present moment, she has been free from headach and from pain, numbness, or debility of the limbs. The vision and hearing are natural; the appetite good; the bowels regular, and the sleep natural. In short, there is not the slightest deviation from sound health, except in the particulars I shall relate.

"Some few months ago she had some difficulty in using the tongue, and in expressing particular words. This difficulty has gradually increased, and now she cannot protrude the tongue, or even move it. She has lost her speech altogether. The tongue itself is soft and pulpy; but it retains its sense of taste and of feeling. The deglutition is impaired, and occasionally she is distressed with a sense of suffocation, in attempting to swallow food, which she is now obliged to do with great care. She cannot hack up any thing from the throat, nor draw any thing from the posterior nares by a back draught. The features of the face are quite natural, and the skin retains its feeling. The saliva occasionally flows from the mouth, &c.

"*Preston.* R. W. Robinson, M. D."

In the body of the work, the offices of the three nerves of the tongue are slightly sketched out. This case is descriptive of a paralytic affection of the ninth nerve, a cerebral and motor nerve; and therefore I gave it as my opinion that the symptoms were more alarming, as proceeding from the brain, and threatening apoplexy.

When I have cut the ninth nerve in a dog, the motion of the tongue was lost, the power of feeding himself was lost, and it was necessary to destroy him. The power of deglutition, however, was entire, when the morsel was put within the touch of the back part of the tongue, and the grasp of the fauces. The motion of the tongue to turn the morsel in the mouth was lost, and there was inability to place it in the fauces, but no other defect resulted. This seems to be exactly the condition of this lady. That she can swallow, is evident from her surviving the attack, which circumstance declares the glosso-pharyngeal nerve in activity; and we are told that she had the taste and the natural feeling of the tongue, that is, the function of the fifth nerve was entire.

I recommended in this case nauseating medicines, leeches under the mastoid process, and a seton across the neck near the occiput, and any local appearance of gout to be encouraged.

I attended at the same time a young lady who could not swallow, and a boy who entirely lost his speech: I had the latter under my control, and can vouch for the accuracy of the detail. Suspicions often arise that a trick is played off when these curious nervous attacks are witnessed. The anatomy of the nerves, and the study of their functions, should enable the physician to examine symptoms with accuracy, to distinguish the natural train of connexions which cannot be imitated, and thus to banish suspicion.

No. CXXIII.—*Case of Frederick Hill, æt. 10. Loss of Speech.*

"*Middlesex Hospital.*

"This boy cannot speak, and therefore is accompanied by his mother. She says that from childhood he has been subject to a pain in his ear. About twelve months ago, he was seized with an obstinate pain in his left ear, which gave him no rest, night or day. The pain extended to his head and face, and appeared sometimes to be in the bones of the forehead, and the sockets of his eyes. It then affected his teeth, and he had toothach in every tooth in his upper jaw. After this his left eye became much affected, and he lost his sight.

"From this attack he recovered, as she describes, by large bleedings, and injections into his ear, leeches behind the ear, shaving the head, and the application of blisters. Twice he heard something crack within his head, and these sensations have been followed by the discharge of matter from the ear, with relief. The discharge does not seem to have been trifling, for she says it was at one time constant for some hours, and the fever and pain were so great, that he became delirious, and he was restrained with great difficulty by means of a strait-jacket.

"It should have been noticed, that, when at the worst, he was so irritable, that the slightest unexpected noise, even the striking of a clock, would bring on one of his fits. About five weeks ago, he began again to complain of pains in his ear, which increasing, brought on delirium before night. He was now unable to eat or move his jaws, or even to speak, such motions producing a crackling pain in his ear. The day after this he was seized with a fit, in which it required two men to hold him for about half an hour, during which time he was insensible; and when it left him, and his senses returned, he was speechless.

"On the 7th October he was admitted into the hospital. He had then a discharge from his ear, accompanied with pain in the temple, and was relieved by leeches and fomentations. About a week after his admission, he threw himself down in a violent fit of passion, as it would appear, and from this moment he was entirely deaf.

"Another striking circumstance has arisen since that time. His left arm has become useless: it hangs by his side, and he cannot raise it. He can move his fingers, but not his arm; and from the middle of the arm to a little below the elbow it is acutely painful when touched.

"He is now brought under Mr Bell's care, who has made a particular examination of his condition. The actions of respiration are perfect. When he smiles, there is no inequality in the action of the muscles of the face. He is reported to make noise enough in laughing. When cupped, he hollowed out, and they thought every moment he would speak, yet there was no articulate sound. The boy is acute, and understands every thing communicated to him by writing. When by this means he is asked to speak, and when the throat is grasped during the effort, there is not the slightest motion perceptible in the muscles of the tongue. Yet he can masticate and swallow with ease: he can nearly touch the point of his nose with his tongue; he can turn it down to the chin and sideways. When his surgeon's name is written, and he is asked to pronounce it, he remains fixed with his mouth open. When by signs he is told to close his lips in the manner necessary to pronounce the letters *b* and *p*, and when he is then asked to pronounce these letters, there seems an utter inability. The consent of action between the chest, larynx, and mouth, seems to be lost.

"This patient was repeatedly purged with calomel and jalap. He had leeches applied behind the ear, fomentations to the side of the head by means of steam, and blisters.

"Nov. 22.—This boy's condition is considerably improved. He tosses the arm which was affected over his head, smiling obviously in exultation. It is reported that he is now able to whistle; and as this is an action in which the muscles of the chest and lips are associated, it appears to be a contradiction to a former statement; but on witnessing this attempt, we find that he makes a faint noise by drawing in his breath, and that, in fact, he cannot whistle. He is asked if he can hear himself whistle, and he says no. Being urged to say how he knows when he is whistling, he takes the slate very readily to write, but finds a difficulty in expressing himself.

"Nov. 24.—A slight spasm observed on the lower lip.

"January 7.—About a fortnight ago, this boy, being distressed with the confinement of the hospital, made entreaties to be dismissed. He came to-day, with his mother, among the out-patients. She says he thinks it hard to be tormented when there is nothing the matter. He would do any thing to avoid blistering, and being promised that nothing should be done to him if he will make a noise and try to speak, his mother telling him to call the cat, he attempts it very readily. His efforts confirm the former statement, that he is incapable of putting the tongue and larynx into co-operation in speech. The mouth is shut, the tongue and larynx perfectly still, and he makes a noise by impelling the air against the posterior nares. It is still necessary to communicate with him by writing.

"Soho Square, July 5.—The mother brought her boy to me this morning, and gave me the following account. The terror of the boy, and his extreme violence, prevented her from following up my advice, but three mornings ago he recovered his hearing and his power of speech at the same time. She had just been observing that he could not be very ill, since he was tumbling about, and throwing his heels over his head in bed. Soon after his sister came running down stairs, saying that her brother could speak, and a quantity of matter had come from his head into his mouth. From that moment he could hear, and with a painful degree of acuteness, the boy saying that the air rushed through his head. She describes his voice, too, as at first unnatural, and as if he spoke with difficulty ; a circumstance which cannot surprise us, when we recollect that it is nine months since he could speak a word. He has at present an extreme tenderness in the upper part of his head, and cannot bear to be touched there. His mother says the matter which came into his mouth was very offensive. A little matter comes from his ear. There is cotton in his ears, but it is for the purpose of dulling the sensation."

This case of Hill's is not demonstrative, for happily there was no dissection to ascertain the precise nature of the injury to the nerves; but it is illustrative. There appears to have been an abscess, originally produced by the disease of the temporal bone, and affecting the nerves of the base of the brain, first affecting the fifth nerve, and then spreading its influence to the seventh and ninth. If the disease had produced its influence mechanically and by pressure, there would have been no obscurity, and one side only would have been affected; but I imagine that the inflammation had disturbed the operations of the nerves, without altogether destroying their influence, deranging, for instance, the fine associations necessary to speech, without arresting the action of the muscles of the tongue.* It is remarkable that the bursting out of matter, probably from the Eustachian tube, had such an instantaneous and simultaneous effect in restoring both hearing and speech.

The want of the power of swallowing, and the want of power of speaking, when occasioned by remote irritation, are not more extraordinary than the sounds which are produced from the same cause.

I have been consulted by a young lady of fifteen years of age, who had a convulsive barking noise like a cough, excepting that the larynx was alone affected, and there was no conforming action in the pharynx, velum, and lips. She would sometimes cough naturally in the intervals of this noise, but this natural coughing did not interrupt the return of the unpleasant hard bark at the rate of ten times in a minute; it ceased when she was asleep, but the moment she was awake the family heard the noise, intolerable from repetition. It continued a month, and returned three successive winters.

I have seen an instance in a young woman, where the same cause produced a more permanent and alarming effect, a spasm in the glottis, so continued and so severe, that the attendants called upon me to perform laryngotomy.

All the subjects of these odd cases, which we do not understand, get well. This is consolatory to a patient, certainly, but not very satisfactory to ourselves. Ought it not to be a question, What nervous affections are consequent on trivial irritation? Without entering on the question, whether disordered health be followed by the imperfect and deranged action of the uterine system, or whether the latter be the primary disorder—the ovaria are the source of irritation; and the consequences are exhibited through the most susceptible system of nerves,—the respiratory system. Hence the disorder of the stomach, the spasms, globus, the difficulty of deglutition, the aphonia: hence the affection of the countenance, the tears, the sobbing, and spasms of the eyes and face, and throat, and chest, and stomach.

---

* See Dr Abercrombie's cases in the Edinburgh Medical and Surgical Journal, July 1818.

No. CXXIV.—*Affections of the Tongue and Mouth, &c.*

——— This much respected old lady has died suddenly. She often consulted me on account of a sensation of a hair across her tongue.

No. CXXV.

Sir B. D. has a nervous affection of his voice, and complains of hairs in his mouth. This is of long standing. His brother beginning to speak inarticulately, was purged with scammony and calomel, bled from the hæmorrhoidal vessels, and had cold lotions to the head, when the attack passed off.

No. CXXVI.

The Hon. Mrs F. Feels a hair drawn across the tongue; is continually working with the tongue, and speaks as if she had something in her mouth. A bitter taste in her mouth: "pure water tastes like Epsom salts:" has a strange sensation in the front teeth, as if clagged with something like gum or wax.

No. CXXVII.

Patient with Dr Marshall Hall. Apparently about sixty: his intellect I ought to say entire, since he was complimentary, but with a manner singularly in contrast with any thing like interest. All the lower part of his face is relaxed in paralysis; the lips hanging loose; speaking consequently very imperfectly. The same inactivity and want of expression in his nostrils. He has lost the left eye, and he has to hold up the eyelid of the right eye with the finger to see us. He closes his jaws very feebly, and there is a sensible defect of action in the masseter and temporal muscles of both sides. His complaint commenced about three years ago, in an extraordinary weariness of the jaw, while at dinner, and which now continues. The taste is natural, and the sensibility of the tongue entire; but the action of the tongue feeble, so that he must use his finger sometimes to assist it in moving the morsel. He cannot spit out. There is a complete paralysis of the velum and uvula, so that when he drinks the fluid comes out through his nose. He has great difficulty in swallowing, that is, in propelling the morsel from the dorsum of the tongue into the pharynx. This, at present, is the most serious and pressing evil.

No. CXXVIII.

Mr L. a surgeon, under Sir H. Halford's care. He is distressed and anxious, in consequence of insensibility of the side of his tongue; his mouth on the same side is insensible, and also the outside of the lower lip. In eating, the morsel turns over, by an involuntary action, to the other side of the mouth. He, too, feels as if the cup were broken. There is a numbness in his teeth and gums; occasionally the cheek is caught between the teeth. He is under a course of mercury. I advised him by all means to proceed. It is a deep affection of the fifth nerve, but so insulated that I am under no alarm. (This gentleman visited me often during two winters, but no change took place in his complaints.)

No. CXXIX.

This gentleman consults me on account of rupture, but is more desirous of telling me the extraordinary state of his deglutition. He says he has a throat that will swallow any thing—a whole egg for example; "but when I am chewing, hip! over it goes before I am aware, and I cannot help it!"

No. CXXX.

I saw a dumb child in the hospital yesterday—deaf, and dull, and stupid. This child, brought by Mr Chinnock of Brompton, forms quite a contrast. He is six years of age, all spirit and action; looking at me, he puts his finger on his wrist, shews his tongue, and touches my watch chain; and his action is as quick as one speaking on his fingers, and with an intelligence and meaning like the acting of Mrs Charles Kemble in Deaf and Dumb. The difference in these children is, that this has hearing and all his faculties. He laughs, and gives the sound of cachination, and cries audibly in pain, but he cannot put out his tongue from his mouth: cannot articulate: and appears from birth to have been deprived of every motion which belongs to the ninth nerve.

No. CXXXI.—*Paralysis of Childhood.*

Mrs B.'s child: Dr Davis in attendance. The left leg is "blighted;" there is a weakness of the whole left side. The child is subject to a different attack; a sudden falling of the jaw, and lolling out of the tongue, and inability to speak. She then appears like an idiot. No sooner do the bowels act than these formidable symptoms cease; even the operation of an enema has the effect. There is an increase of the weakness of the side after these attacks.

No. CXXXII.

——— With Dr Cobb. This child, three years old, has totally lost the use of the lower extremities, and the right arm was at first very weak. The case is a common one, with this exception,—at one time she could give out no sound or cry. The parents saw from the expression of the face that she was crying, but no sound accompanied the effort.

No. CXXXIII.

——— a young lady of sixteen. She has a difficulty in eating. Complains of stiffness in the jaw. On opening the mouth to a certain degree the jaw is jerked to the right side, so that the mouth opens obliquely. I should say that this complaint is in the articulation, but that it is affected by alarm, or by company, and is attended by stiffness in the muscles of the back of the neck.

No. CXXXIV.

——— With Dr Carnegie, Dorsetshire. The young gentleman complains of difficulty of swallowing. He has had no sore throat or inflammation: it appears that the difficulty comes on during meals: sometimes large morsels pass. The probang passes easily: requires only medical treatment.

No. CXXXV.

——— a clergyman, nine years in orders. A sudden incapacity seizes him, especially in a word beginning with G or B; and when a sentence begins with a vowel, he cannot proceed: " yes, when I raise and distend the chest, it relieves me, but not always." It feels as if the difficulty were seated in the chest. It is a sensation like that of sudden alarm. Anxiety has nothing to do with it. It has come on when reading prayers to my own servants; whilst he has freely discoursed in St Paul's: certainly much affected by the state of health; and he has a presentiment that he shall be incapacitated. Had the defect when a boy, but thought that he had got the better of it.

No. CXXXVI.

Dr R. of Wexford: by Sir J. M'G. His complaint is an affection of speech. It is interrupted without an assignable cause, ch. ch. ch.: cannot propel the breath: sometimes, too, he cannot swallow, and putting the glass to his lips, he is obliged to put it down untasted.

He has no palpitation; no distress in ascending the stairs; no pain of the side of the chest or arms; no disturbance of the vascular system; no symptoms of gout. It appears to have commenced with a rheumatic attack in the muscles of the chest, and an affection of the diaphragm. The impediment now commences in the diaphragm, which acts in a succession of impulses, attended with an impediment in utterance. The sensation is deep in the chest: worse on using the baths at Buxton.

No. CXXXVII.

——— He complains of continual sound in his ear, and deafness. Being deaf for years, he has had lately three days of perfect hearing! The continual sound more than the deafness gives him apprehension. The sound is that of a high wind: it will suddenly cease, and be succeeded by the noise of water issuing from a small pipe: it will suddenly alter from the rushing of water to the ringing of a tuning fork. There is dryness or want of wax in the tube.

It is important to distinguish when these sensations are from the state of the organ, *i. e.* the apparatus of the ear; or symptomatic of a condition of the brain.

How much may we attribute to accumulated sensibility of the nerve? We see psoriasis, dryness of the tube, defective secretion of wax, thickening of the membrane, deafness, and, combined with these, incessant sound in the ear. In such a case, the cause is in the outer organ, and we need not attribute the condition to the brain, nor alarm the patient with serious consequences.

No. CXXXVIII.

——— son of Sir H. D. He is deaf from suppuration in the ear. I took the opportunity of asking whether he had singing in that ear. He has none. In other cases I have found it to occur. Does not this destroy the theory of accumulated sensibility in the nerve?

No. CXXXIX.

This gentleman is from Madras. At the distance of about three weeks he is subject to an attack. It begins with oppression and sighing; this is succeeded by vomiting. After the contents of the stomach are discharged there is pure bile. During this he hears voices, and somebody talking to him; this delusion continues for some days. Now he is sensible of the delusion, but he was not at first. Had you no pains of head, no affection of eyes? "O yes! at one period I saw all sorts of images, and vomited all sorts of creatures."

No. CXL.

A young man, a commercial traveller, complains of singing in his ears, —sparks of fire before his eyes,—pain in the heart,—strange sensations, with fear of falling, and constant terror of death. Pale urine; bowels constipated. He has had several fits: he is aware of their approach by a pain in the right arm, and a sensation coming from the lower extremities to his stomach. Epileptic.

No. CXLI.

Mrs F. is an old lady; subject to attacks which give rise to some contest whether they are epileptic or apoplectic. The fit has been over when I have been called. She knows the attack is coming on by an offensive smell, which no one besides is sensible of. After being insensible some time, she recovers her senses, but with the conviction of strange creatures being in the bed; yet she converses sensibly. If asked if the delusion be gone, she will say, "There they are, do not you see them; what else can raise the bed-clothes so?" Then she becomes sensible of the delusion, and ashamed of her fancies.

After five different attacks, preceded and followed by similar symptoms, at the distance of a month, she had a fit from which she did not recover, and died with every symptom of apoplexy.

I have lost the note of a lady's case, who complained that the smell from her kitchen was intolerable. And although others affirmed the odour to be inviting, to her it was the offensive smell of carrion!

No. CXLII.

Mr L., æt. 55. Once in three or four days he is seized with a dreadful smell, "horrible as can be imagined, which unmans him and runs through him." He flies into the air for relief. In the mean time no one perceives any thing of the kind. There is discharge from the nose. He experiences no giddiness nor apprehension, nor is any other sense affected. He was attacked when in the open air; being out with the artillery during the coronation. Formerly constipated in an extraordinary degree; the bowels are regularly relieved on the fourth day.

CASES ILLUSTRATIVE OF THE DISTINCTION OF THE NERVES OF RESPIRATION AND VOLITION.

Within the space of one month the three following instances of fracture of the vertebræ of the neck have occurred in my practice. In one instance the bones were broken at the lower part of the neck, and the patient lived some days. In the second instance, the vertebræ of the neck were fractured in the middle of the neck, and the man lived half an hour. In the last instance, the uppermost vertebra was fractured, and the death was immediate.

No. CXLIII.—*Cases of Fracture of the Spine.*

CASE I.—*Percy Ward*, 29th May.—Charles Osborne, ætat. 26.—On Saturday evening this man was putting pulleys into a window-sash when the small steps on which he stood slipped from under him, and he was precipitated through the window into the area, a height of thirteen feet. He thinks he fell upon his back; but he is uncertain, as he lay for some time senseless. He lies now in bed, supine and powerless, but describes the part injured to be the spine between the scapulæ. (As we desire to mention only the essential features of this case, it is better to say at once that this was a deception, that he felt the pain of the injury at a point considerably lower than the fracture, and that on his death it was discovered that the arches and bodies of the sixth and seventh cervical vertebræ were broken).

The lower extremities are motionless and insensible. He can raise his shoulders and bend his arm, but over the motion of the hands he has no power.

Another report adds—His expression is singular; he says he can move his arm by the strength of his shoulders, which is exactly true, for by moving the shoulder he can give a certain rotary motion to the humerus, and, consequently, move the fore-arms when they are bent at the elbow. The skin of the arms, however, retains its sensibility to the point of a pin. The abdominal muscles are relaxed, and the viscera feel flaccid. He can make no effort to expel the urine; his urine is drawn off by the catheter, and his fæces pass involuntarily: there is priapism. When I induce him to attempt an effort and to strain, no change on the abdominal muscles can be felt; there is no firmness or rigidity in them. The integuments of the abdomen and of the chest, as high as the nipples, are insensible.

His breathing is frequent, and at each inspiration the chest is heaved with a short and quick movement: at each expiration the abdomen is protruded with a sudden shock and undulation. The belly, during this effort of breathing, is uniformly soft and full; when drawn in, it is by the elevation of the ribs, and when the chest falls, it is protruded.

He has been observed to yawn naturally. Query—Can he cough?

An examination has been made to-day to answer this query. When he is asked to cough, he pulls up the ribs and extends the chest, and lets them fall: he coughs, but not strongly: it is obviously by his power of raising the chest and giving elasticity to the ribs, and by the weight of the parts falling, that he is enabled to expel the breath. He cannot divide the expiration into two coughs, nor give two impulses to the air; but each time he coughs, the elevation of the chest must precede it.

On spreading the hands and fingers on the side of his chest the action of the serratus muscle could be felt, and also the lower margin of the trapezius muscle was felt to become firm during the act of inspiration, as when he prepared to speak.

Being asked if he had sneezed by any chance, his answer was—"No, sir; I cannot blow my nose." This was not that he could not raise his hand to his head: he was conscious of wanting the power of forcibly expelling the air. Mr B., taking a handkerchief from a nurse, and holding the patient's nose as a woman does a child's, the patient could not blow the nose; he could not give that sudden impulse of expiration which is necessary.

In one of the reports of this case it was stated that the patient was disturbed by horrible dreams. This is very likely, from the respiration being in part obstructed; but it was omitted to verify that observation during the patient's life.

It is remarkable in this case, that on feeling his stomach, he of his own accord marked the difference of sensibility, internal and external. He says he feels internally, but he does not feel on his skin. He feels me when I press the stomach, and has complained of the griping from his medicines.

This man died in the night of the seventh day from the accident. The night-nurse gave no particular description of the manner of his death, further than that he seemed desirous to speak and could not: he made attempts to articulate, but was unable.

No. CXLIV.

Case II.—James Saunders, ætat. 45, June 30.—This man fell only four feet, but he fell backwards, and struck his neck against an iron-railing. The transverse processes of his fifth and sixth cervical vertebræ were found to be fractured; and there was diastasis of the articulations between these vertebræ. The body of the sixth vertebra was fractured. The spinous processes, also, of the fourth and fifth vertebræ were found fractured at their bases.

The house-surgeon reports of this man, that when he was brought into the hospital he was perfectly sensible; that his face indicated great alarm and anxiety. Every time he drew his breath it was attended with an effort to raise the shoulders, and a contraction of the muscles of the throat: every time he breathed, his head appeared to sink beneath his shoulders. On putting his hand on the pit of his stomach no motion of the viscera of the abdomen could be perceived. He had no feeling even in the upper part of his chest: he had feeling on his face and neck, and indistinctly near the collar bone. He had a motion of his hands, a sort of rolling motion, which may have proceeded from the shoulders. When he spoke it was in a tremulous voice, like a man frightened: his voice was weak, but he did not speak in a whisper: the sound of his voice was more like sighing than common breathing. The pulse was felt at his wrist. In ten minutes after he was brought in, half an hour from the time of the accident, he died.

No. CXLV.

Case III.—On the following day a man was brought into the hospital dead. He had fallen fifty feet, and alighted on the ground upon both his shoulders. By the accounts of the men who carried him to the hospital, he appears to have been instantaneously killed. The dissection sufficiently proved that he was killed suddenly. For, besides extensive fracture and injury to the lower part of the spine, the atlas and dentata were found fractured. The tooth-like process of the vertebra dentata was broken through just at its base. It was separated completely, and was found embraced by the transverse ligament in its natural situation upon the atlas. The arch of the atlas was partially fractured on each side, and a portion of its body, where the process of the dentata rolls upon it, was also fractured and detached.

By this fracture the medulla oblongata was injured, and the breathing instantly interrupted.

No. CXLVI.

A young man was brought into the Middlesex Hospital, who had fallen upon his head. He soon recovered, and lay for some time in the hospital without exhibiting a symptom to raise alarm. He had given thanks to the assembled governors of the hospital, and had returned into the ward for his bundle, when, on turning round to bid adieu to the other patients, he fell, and in an instant expired. Upon examining his head, it was found that the margins of the occipital hole had been broken: no doubt it had happened that, in turning his head, the pieces were displaced, and had closed and crushed the medulla oblongata as it passes from the skull.

No. CXLVII.

A man was trundling a wheelbarrow in Goodge Street, which is immediately adjoining the Middlesex Hospital: in going from the carriage-way to the flag-stones he met the impediment of the curb-stone. He made several efforts to overcome it, and at length, drawing back the wheelbarrow, he made a push, and succeeded; but the wheel running forward, he fell, and remained motionless. He was taken into the hospital, but was found to be quite dead. The tooth-like process of the second vertebra of the neck had burst from the transverse ligament of the first. The impulse given to the head had done this violence, and had at the same time carried forward the spinal marrow against the process, and on which it was crushed.

These two last cases occurred before I was surgeon of the hospital, but I have had two instances of sudden death from dislocation of the atlas from the second vertebra of the neck. In short, the fact is perfectly well ascertained.

No. CXLVIII.

A patient, who had a deep ulcer in the back part of the throat, was seized with symptoms like those of apoplexy. These symptoms continued for two hours. At this time the patient's head fell suddenly forward, and he instantly expired. On dissection, it was found that the ulcer had destroyed the transverse ligament, which holds the process of the dentata in its place. In consequence of the failure of this support, the process was thrown back, so as to compress the spinal marrow. The parts are preserved in my collection.

We have here another proof that when the medulla oblongata is crushed, the death is instantaneous; and that the respiratory nerves, being those of expression, no contortion or mark of agony accompanies this sudden death. But there is another important feature here: the apoplectic symptoms preceded the crushing of the spinal marrow. If this disease had occurred lower in the spine, it would not have been different from the common case of paralysis of the lower extremities from disease of the vertebræ, where the communication of inflammation to the spinal marrow or its theca, and not the mechanical pressure of the bones, occasions the defect of sensibility and motion.

No. CXLIX.

A man was brought into the hospital, having had a severe injury of the head. Two attendants were doing their duty to him; one was letting blood in the arm, whilst the other was shaving his head: the blood suddenly stopped, and the operator looking up, saw that the patient had ceased to breathe, and was without motion or expression of any kind. On dissection, it was found that the fracture had gone through the foramen magnum of the occipital bone, leaving a loose portion. By merely turning the head in shaving, the loose portion of the bone had been turned upon the spinal marrow, and crushed it.

I have seen various examples of fractured spine, but none better calculated to illustrate the function of the nerves of respiration than those described above. But the following case of diseased vertebræ is very instructive.

No. CL.—*Case of Palmer.—Effects of Disease of the Spine.*

" October 4. 1825.—James Palmer, æt. 16, was admitted into the hospital, under the notion that he was suffering from a blow upon the head. But, on inquiry, it was found that he received no violent injury, and that a man, in good humour, had struck him with his open hand on the top of the head. It is not possible that this could have hurt him, unless the disease we are presently to describe had made some progress.

" The surgeon, on examining this patient, and hearing his story, directed his attention to the spine, and on feeling the nape of his neck, he desired that a minute account of his history should be made out.

" The patient states, that about three months ago he caught a violent cold, attended with sore throat, and stiffness and swelling round the neck. When the general swelling subsided, there came on a swelling at the back of his neck, which continued to increase until he felt a numbness in parts of his arm and fingers, and likewise in the leg. He at length lost the use of the right arm and leg, and was brought here in the condition to be described.

" There is a swelling round the spine on the back of the neck. It is a thickening of the ligaments and cellular membrane around the bones; the tumefaction is greatest on the right side of the neck. He complains of no pain, and to a certain degree he can bend his neck. He requires assistance to move either the arm or leg of the right side. The left side is less affected. On the 8th of October an issue was made on each side of the cervical spines. They were made with a cut of the scalpel, and bled freely. Next visit he was sensibly better; he could move his arm and leg. But on the following visit he was in the same state as when admitted.

" It being supposed that so immediate and so short an influence could only be attributed to the loss of blood, eight leeches were applied round the issues, and ordered to be repeated.

14th.—Within the last few days he is worse. He complains of more numbness, and can neither move leg nor arm. He has pain down the right side of his neck. When he attempts to move the head, he has great pain, and the pain is increased when the head is permitted to fall forwards. A stuffed collar is ordered to be applied so as to support the head in every position of the body, and to give rest to the inflamed vertebræ. The issues to be frequently touched and kept active, and leeches to be applied round the issues. His bowels are attended to.

" 18th.—This boy breathes better, feels better, and turns his left hand more freely: and, as the pulse admits of it, the leeches are to be continued.

" 19th.—To-day he is certainly not better. He lies a little twisted; his breathing is more laborious. He complains of the difficulty of breathing, and being asked to say in what respect, he says it requires more effort in speaking, and he cannot continue it without increasing difficulty.

" 20th.—He is worse to-day. Upon being asked for his hand, which he supposed was lying across his breast, he was much surprised to find it lay by his side.

" 25th.—His breathing is difficult; he complains of a sense of weight upon his chest; his voice is much more feeble. He cannot call out; and when he endeavours to do so, it is very feebly; and he says it appears as though his voice came from his neck. On examining the muscles by which he breathes, we readily discover the sterno-cleido mastoideus in strong action. The abdominal muscles are totally inactive and loose.

" 7th January.—From the wasting of the abdominal muscles the motion of the intestines can be seen through them, and from their state of relaxation the hand can be pressed very deep under the scrobiculus cordis; in doing which he is sensible of pressure against the stomach, although insensible on the integuments of the belly. When he attempts to cough, he raises his chest, but can give no impulse in discharging the air; he expires by the falling of the chest merely.

" Among other circumstances it deserves notice, that, when asleep, his thighs are involuntarily drawn up; and of late his limbs are thus continually drawn up, and he has no power of pushing them down. About a week ago he was attacked with pain in his head, and had the sensation of water trickling down into his ears; since which he has been deaf.

" Sept. 1.—It is now some months since any note has been taken of this case, and the improvement is remarkable. The motion of the right arm first returned, and then of the left. He afterwards began to move his right leg, and then the left. At last he managed to get out of bed, and crawl about the ward: he is now, with the aid of crutches, able to walk to the water-closet. He complains of pain in his jaw on the left side.

" In all this time, the treatment has consisted of attending to his torpid bowels, that no distressing accumulation might take place; and care has been taken to keep the issues in his neck active, and to preserve the vertebræ from being moved.

" Mr Bell, who is curious to observe the effect on his voice, makes him call the nurse, which he does now of himself whenever he sees his surgeon approaching on the visit. This is to shew how much he improves. When this experiment was first made, he raised his sternum by evident exertion, and let it suddenly go down in pronouncing the word, nurse. Of late the power of enforcing the voice by the action of the muscles of expiration has been regained.

"28th.—He now walks about the ward, and has the use of both legs and arms; but the right arm is the weakest.

"He knows when the fingers of the right hand are touched; but if you close them while his head is turned away, he is not aware of their position, unless the points of the fingers touch the palm; so that if you extend the fingers, he says they are bent. His speech is much improved, and all the functions of the body restored."—"Was made an out-patient."

This case of Palmer is very interesting, and abundantly confirms the result of the cases of fracture of the spine. By the progress of inflammation beginning in the vertebræ, and propagated to the spinal marrow, we see the function of the spinal marrow slowly debilitated, and at length the symptoms coming to resemble those produced by the crushing of the spinal marrow by the broken vertebræ. But here we can observe the gradual failure of strength, and the consequence of inactivity, in the wasting of the muscles. The most remarkable effect of this was the possibility of seeing the intestines moving, and the relaxed abdominal muscles partially rising and falling according to the distention and contraction of the intestinal canal. This state of the abdomen permitted us to examine the stomach, and to ascertain that its sensibility was entire; and it is fair to conclude, that this was through the influence of the par vagum. The branches of this nerve to the stomach, like its subdivisions to the larynx and pharynx, are in possession of two functions; the peculiar sensibility of the part is bestowed, and the arrangement of the muscles is formed, through its influence. It must be remembered, however, that this double office proceeds in all probability from its receiving additional branches from the spinal nerves just as it is emerging from the base of the skull.

As the symmetrical system of nerves to the trunk became impaired, the muscles supplied with the accessory respiratory nerves became more excited, and rose higher into action. At the same time, the voice became feeble. This is easily understood, for the strength of the voice results from the impetus with which the breath is expelled. In this case, the active muscular power of expelling the breath was lost, with the other voluntary powers of the trunk and extremities; and by this we see the importance to life of these accessory nerves of respiration, for continuing to possess power over the diaphragm, serratus magnus anticus, trapezius, and sterno-cleido mastoideus, they supplied a force of inspiration sufficient to preserve life, until amendment took place in the spinal marrow, and common spinal nerves. No one, I apprehend, will be bold enough to affirm, that if the muscles of the neck and trunk had been as entirely deprived of action as the abdominal muscles were in this case, the patient could have survived by the mere action of the diaphragm.

If the diaphragm were to act alone, it would pull down the margins of the chest; and in as far as the diaphragm tended, by its action and by its descent, to produce a vacuum, the ribs, by their yielding to the action of the diaphragm, and their descent, would render the muscular effort nugatory; for inasmuch as the cavities of the thorax would be enlarged in their long diameter by the descent of the diaphragm, so much would they be diminished transversely by the descent of the ribs and sternum. But when the serratus and mastoideus raise the thorax at the same moment with the contraction of the diaphragm, circumstances are materially altered. The ribs and sternum are raised against their elasticity, and consequently opposed to that state to which they would recoil even in death. The expansion of the margin of the chest increases the effect of the muscular effort of the diaphragm, the arch of that septum is contracted and bears down, and the abdominal viscera are lifted up, which, on the cessation of effort, recoil by gravitation into their position; and thus the elasticity of the ribs, and the weight of the parts opposing the muscles of inspiration, preserve the life when the muscular power of expulsion is gone. There would in like manner be a defect in *expiration;* for if the diaphragm acted alone, the margins of the ribs would be drawn down, and when it relaxed, they would fly up by their elasticity and expand the chest: thus interfering with expiration.

That accomplished physician Dr Cooke, conversant as he is with all authorities, touches on that of Boerhaave. "Boerhaave notices the fact, (of the organs of respiration and the action of the heart being entire in paraplegia), and observes, in explanation of it, that the moving powers of the viscera can scarcely be said to arise from the nerves of the spinal marrow, but from the fifth, sixth, and eighth pair, and the recurrent nerves of Galen." I hope it is not necessary to prove that these nerves are altogether insufficient for the purpose. This admission of the opinion of Boerhaave by an author whose work immediately preceded the publication of my papers, and by one so fully informed by study and experience, shews how long this department of our science has been stationary.

No. CLI.

The case of Mrs G., Berkeley Square, has recurred to me. That lady's condition was very interesting, and might have been used as illustrative of my views of the nerves.

She was quite helpless, sat in a reclining posture, supported with pillows, and surrounded by officious relations and maids, for she had her eyes and her senses. She had totally lost the use of all the voluntary muscles; her legs and arms lay motionless; her tongue refused utterance; she attempted to speak with her mouth open, and, in a manner, from her breast; her eyes moved, and were expressive; her face had expression, she smiled pleasantly, and could frown.

Her great suffering was an indefinable uneasiness and consequent fretfulness, which gave the attendants much trouble in lifting her, and turning her continually. That she could swallow, her long suffering sufficiently proved. She breathed easily.

The remarkable circumstance here, was the total want of all motion of the bodily frame, unless in the actions of respiration, which were perfectly free.

In the former edition I mentioned this case; but the above note, which is somewhat more particular, I have since found among my papers. I knew little of the subject at the time I attended this lady.

No. CLII.

" *Lynn, March* 6. 1829.

" Dear Sir,—The case to which you allude I recollect transcribing partially from my notes, and forwarding to you, in April 1827, as follows:—' The power of moving the limbs entirely lost; can utter only indistinct guttural noises; senses of sight, smell, taste, hearing, and feeling, perfect; breathing regular and easy; eyes bright; countenance natural in expression; deglutition defective; the effort often exciting distressing paroxysms of cough and choking; contents of bladder and rectum regularly evacuated; though latterly, at times, with some difficulty.'

" I was called in at an advanced period of the disease, and could not gain a very clear account of the previous progress; but I have much pleasure in extracting from my note-book all the particulars I could collect.

" Two years preceding the above report, the lady, upwards of fifty years of age, of a delicate, nervous temperament, whose health previously had been tolerably steady, sustained a severe fall, striking sharply the lower part of the spine, and back of the head and neck; the immediate symptoms produced were, slight stunning nausea, and faintness, which soon passed off. Some little time after this accident, she complained occasionally of headach and dizziness; and in the course of a few weeks it was observed that she walked hesitatingly, dragging slightly the left leg, which she noticed as feeling weak; to these symptoms succeeded after awhile, hesitation of speech, and an unusual thick guttural pronunciation, and a consciousness of some difficulty of moving the tongue whilst eating or speaking. The left arm now became weak. In this state she continued for a time, when after a second fall, by which the back of the head was forcibly struck against the edge of an open door, the weakness of the left side rapidly assumed a more decided paralytic character, appropriate treatment was instituted, but with little effect, as the right leg began to feel uneasy, from twitching of the muscles, and the hand of that side became weak, and affected with numbness, alternating with pricking and tingling in the fingers; and ere long the state of this arm became similar in all respects to the left: the speech became more and more indistinct; and the difficulty of swallowing gradually increased. Contrivances to enable her to communicate with her attendants were now resorted to; and as long as she was able to direct a small stick to letters printed on pasteboard, she could make those around sensible of her wants and wishes: but for some weeks before her death, she lost all power of moving the hands and arms. My report to you conveys the state in which she continued to the last; excepting that the muscles of the neck lost their power, and the saliva could not be retained in the mouth. It appeared also, from the flaccid state of the abdominal muscles, that the expulsion of the fæces and urine was latterly chiefly effected by the action of the diaphragm.

"At no time, during my attendance, was there any particular acceleration of pulse, or other indication of fever; and never the slightest wandering, or loss of memory. The paralytic symptoms marched on unimpeded by any treatment.

"I could never discover any loss of sensibility; it was natural in degree, and uniform over the whole surface of the body: the slightest pressure of the legs, toes, fingers, or arms, was immediately perceived. During the act of yawning, or sneezing, no motion of the arms was observed. The muscles of the neck and trunk were the last to give way; she could nod, slightly turn the head, and bring the trunk forward, to within a few weeks of her death, after all power in the extremities had ceased. She frequently coughed, and occasionally sneezed; and had the power almost to the last of producing sounds by expelling the air rapidly from the lungs: but it could not be called distinct shouting.

"I subjoin the dissection of this case, which took place thirty-six hours after death.

"The skullcap being removed, the dura mater appeared of an unusually dull bluish cast; and cutting through it, a quantity of limpid serum, to the extent of six ounces, escaped. The pia mater was of a slight milky colour, and many patches of gelatinous matter were effused between it and the arachnoid. I considered the membranes generally as thickened, but the vascularity not unnatural. The substance of the brain might be said to be somewhat softer than usual, but the season was excessively hot, which may account for it. Throughout the mass, nothing was observed that could be construed into alteration of structure. In the ventricles, rather more fluid than common was found: the nerves at the base, and the medulla oblongata, were carefully examined, and appeared free from disease; but the membranes towards the foramen magnum, and the sheath of the cord, as far down as the sixth cervical vertebra, were thickened, and highly vascular; and this was particularly remarkable at the anterior part of the sheath of the spinal canal. I removed the fourth, fifth, and sixth arches, of the vertebræ of the neck, in consequence of their spines projecting, and found the anterior half of the cord, in this space, in a semifluid state, approaching nearly to the consistence of cream, whilst the posterior portion possessed its usual firmness.

"I have been led into this lengthy detail, in consequence of your requesting a minute description of the case; and should any part of it appear obscure, I am ready to answer such questions as you may deem necessary to put to me.

"The fall appeared to bring on low inflammation; effusion was the consequence, and the paralysis the effect of the pressure from the fluid.

"I am, dear Sir, with the greatest respect, very much your obedient servant,
Thomas Ingle."

The reader will perceive the value of this communication, inasmuch as the dissection furnishes a full explanation of symptoms, and a confirmation of the observations made in the original papers.

I give the following instance to shew how independent the act of breathing is of the state of the brain. It is written by an old pupil, on whose accuracy I have a perfect reliance, and whom I expect to see one day in the first rank of his profession.

No. CLIII.—*A Child breathes after the Brain has been destroyed.*

"After the membranes had given way, and the liquor amnii had escaped, the midwife on examining found another membranous bag presenting, which she naturally supposed belonged to a second child, and therefore did not interfere. During the passage of this bag under the os pubis it suddenly burst, and the whole of the brain escaped from the opening very much smashed, and hanging together only by its membranes. The child breathed with perfect freedom, and cried strongly, rolling its eyes about in a wild, staring manner. It moved its lower extremities freely, and that not from spasm, but obviously in obedience to external impressions. There was no motion whatever of the upper extremities.

"In this state it remained for about three hours, when all motion in the extremities ceased; the eyes became fixed, and the breathing gradually slower till it ceased altogether, just seven hours after the birth of the child. During this time neither urine nor meconium passed, nor had there been any hæmorrhage from the vessels of the brain.

"On examination, the occipital bone and the posterior part of several of the cervical vertebræ were found wanting, and their place had been occupied by fluid, surrounded by a membranous bag; an instance of spina bifida of the neck. The spinal marrow was perfect.

"A somewhat similar case occurred to me about three years ago, when I had occasion, from peculiar circumstances, to remove the brain of a child through the anterior fontanelle. In that instance, about ten minutes elapsed before its birth, yet it drew a deep inspiration, and would have cried had it not been prevented; and the motions of the lower extremities continued about half an hour, although the whole of the brain had been removed, and a blunt instrument repeatedly thrust down the foramen magnum.

"I am, dear Sir, yours very truly,

"*Berners Street.*" "J. SWEATMAN.

Even the more common case of *hemiplegia,* or the defect of motion in one half of the body longitudinally, affords us the opportunity of distinguishing the act of respiration from voluntary action. For although the patient cannot, by a direct effort of the will, move the muscles of the side of the neck, or of the shoulder, yet when he draws breath, coughs, sneezes, or yawns, these muscles are put in action.*

I have observed, that when the spinal marrow is cut through by a fracture of the spine, and the accessory nerves of respiration alone remain to animate the chest, the patient can yawn, but he cannot cough. Yawning is an act of the respiratory system, in which the muscles of inspiration are slowly brought into action.

The following communication from Dr Abercrombie will throw additional light on this subject; and the intelligent reader need not be informed how successfully this gentleman has cultivated the pathology of the brain.

The note was addressed to the late Mr Shaw.

No. CLIV.

"I think the following case will be interesting to you and Mr Bell. I had some time ago under my care, a man affected with hemiplegia of the left side, the palsy complete, without the least attempt at motion, except under the following circumstances: he was very much affected with yawning, and every time he yawned the paralytic arm was raised up, with a firm steady motion, until it was at right angles with his body (as he lay in bed on his back), the forearm a little bent inwards, so that his hand was above his forehead at its greatest elevation. The arm was raised steadily during the inspiration, and when the expiration began seemed to drop down by its own weight with considerable force. He continued liable to the affection for a considerable time, and it ceased gradually as he began to recover the natural motion of the limb. Very sincerely yours,

"JOHN ABERCROMBIE.

"*Edinburgh, 26th March.*"

---

* The most ingenious men, as Boerhaave and Van Swieten, will, with all their knowledge and erudition, be defective in their account of such cases, from attending to the muscles without considering the sources of the muscular power. See the works of Dr Cooke, in the part Palsy, p. 36.

Spasmodic Twitching of the Respiratory Muscles.

The unpleasant spasmodic actions of the muscles of the face, noticed in the text, are very common. This, in the slighter degree, is continued, in some instances, upon the side of the neck and chest, through the influence of the same class of nerves. The following is an excerpt from a communication on this head.

No. CLV.

" At every interval of three minutes or thereabout, there is a *sniffing* and twitching of the nostril of one side, the eye-lids of the same side are at that moment spasmodically closed, and the angle of the mouth forcibly drawn towards the angle of the jaw ; the chin is tilted upwards and sideways, and there is a wriggle and retraction of the shoulder. While there is this audible sniffing and contraction of the face and shoulder, there appears to be a motion of the diaphragm, and of the muscles of the side of the chest ; and this I judge of in part from the motion produced, but principally from the drawing of the breath, which causes a sound at the moment that the spasm of the face takes place."

This is the description of a very frequent disorder. It interferes with no necessary action of the parts, for it ceases while the patient is actively engaged, as if the voluntary effort could stop the tendency to spasm in the respiratory system; it is, however, increased by agitation and speaking.

These motions are sometimes very ludicrous. In conversing with a patient with nervous affection I could have believed him a cobbler; his forearm being half bent, and his hand closed with the thumb projecting: whenever he became animated in discourse he gave a jerk across his stomach, which I cannot describe more shortly than by saying it was like that of driving an awl through a piece of leather. It was obviously connected with his speech, and I must therefore imagine was an affection of the serratus anticus magnus.

No. CLVI.

" Lorsqu'il (Bonaparte) se promenait, soit seul, soit avec quelqu'un dans ses appartemens ou dans ses jardins, il marchait un peu courbé, les mains croisèes derriere le dos. Il faisait frequemment un mouvement involuntaire de l'epaule droite, qu'il relevait un peu, et en méme tems un mouvement de la bouche de gauche à droite. Si l'on n'avaient pas su que ces deux mouvemens musculaires n'etaient qu'un *tic* d'habitude, on aurait pu les prendre pour des mouvemens convulsifs. Au reste, ces mouvemens etaient les indices d'une grande pre-occupation et d'une sorte de congestion d'esprit, quand il nourissait de grandes pensées. Ce fut souvent après ces promenades qu'il redigea, où qu'il me dicta, les notes les plus importantes."—*Memoires de Bourienne.*

No. CLVII.

Note—The gentleman who came in to me this morning has the slighter degree of spasmodic affection of the face. There is a tremulous motion of the eye-lids of one side, which is sometimes accompanied with a drawing of the corner of the mouth. It begins with a twinkling of the fibres of the orbicularis muscle, and is followed by a sardonic grin, owing to a slight contraction of the muscles inserted into the angle of the mouth; with an agitation of the cheek like the effect of emotion, as if he were about to cry. It comes on when he is anxious, or when people look steadily at him. This nervous affection seems to have been produced by great depletion; it occurred about seven years ago, after an inflammation of the chest, for which he was bled on five successive days. I must recollect, however, that he is subject to spasmodic asthma, for which he says it is necessary to undergo bleeding and blistering. He comes to me in the expectation that I should do some operation on his face to stop this motion. This I could do effectually, but I have explained to him that a worse effect would result in the loss of power over the eye-lid.

No. CLVIII.—*A Spasmodic Affection of the Respiratory Nerves and Muscles.*

"Anne Roper, in June 1825, was admitted into the physicians' ward, having a spasmodic affection of the muscles of the face, neck, and chest, which has no perfect intermission. She ascribes her present condition to having had dysentery, followed by prolapsus ani, a short time ago, which occasioned great distress. She says she has never been well since. Her bowels at present are out of order, and the catamenia are irregular.

"The condition of this woman is very peculiar: in her common breathing inspiration is performed with a sudden spasmodic action: but she is also affected at intervals with more violent spasms, and her respiration is then hurried and distressing. On the commencement of the paroxysm, she bends her body slightly forwards, and thus prepares herself as it were for the attack: her nostrils are dilated widely, the angles of her mouth are dragged forcibly downwards, there is a constriction of the throat, and the shoulders and chest rise convulsively, as when a person has cold water poured upon the head; the inspirations are deep and violent, and are attended with a sniffing of the nostrils, the air being inhaled through them only, and not through the mouth. The fibres of the platysma myoides start into view, and there is a quick rising and falling of the pomum

Adami; the sterno-cleido mastoideus and trapezius on both sides act powerfully, fixing the head and elevating the shoulders.

"The spasmodic action of these muscles exists to a considerable degree constantly, yet it increases in paroxysms which last so severely for a few minutes that she is deprived of the power of speech, and seems to be almost suffocated. These paroxysms recur at irregular intervals. It was observed by the attendants, that when she was excited by walking about the ward or by replying to our questions, they returned more frequently.

"She could move her head with perfect freedom when we requested her, but still the spasmodic action continued. She also raised either shoulder, or twisted her face to one side, when she was desired. This woman continued under the care of the physician for about a month, and was discharged cured."

The case was successfully treated by Dr Southey.

No. CLIX.—*Case of disordered Action of the Muscles of the Neck.*

November 18. 1826.

A gentleman came this morning to consult me on account of a painful and spasmodic condition of the muscles of the side of his neck.

About twelve months ago his mind was exceedingly harassed, and to this he attributes his present symptoms. His countenance betrays want of general health, his stomach and bowels have required attention. He has been consulting the usual fashionable round of medical gentlemen. He has taken five grains of the blue pill at night for some time. His complaint is a wry neck. The position of his head is not constantly awry. He can turn it in all directions, but at times (and I think while conversing with me) his head is gradually and by little and little turned round, until his right ear comes near to the sternum, and the chin is pitched upwards, and to the left side. The sterno-mastoideus is of Herculean strength, and when you grasp it in its state of action, it is as large as the biceps of a powerful man.

The contractions extend to the muscles of the neck and shoulder, corresponding with the distribution of the *nervus accessorius*, or superior respiratory. I made him strip, but could not observe that the serratus magnus was at all affected.*

In this case we have an affection of a respiratory nerve, distinct from the common voluntary nerve, and bearing an analogy with the more common instances, because more observable ones, of the affection of the *portio dura* in the face.

---

* His pain was in the mastoid process behind the ear. But this was an indirect effect of the complaint, and proceeded from the violent action of the muscle.

No. CLX.—*Spasmodic Action of the Sterno-cleido Mastoideus, producing a continual Motion of the Head.*

Anne Turrell, ætat. 19. Northumberland ward.—This young woman received an injury of the chest. The blow was so severe as to break the bone of her stays, and was followed by spitting of blood. The treatment necessary for this complaint brought her very low. She describes herself at that time as oppressed with a heaviness and numbness of one side of her head and face, and having the sensation of cold water poured down her neck. This continued until the commencement of the singular motion of the head, which is the most remarkable symptom in her complaint. Conceiving this condition to be an effect of weakness, she left the hospital into which she was first received. From that time, however, until she came into the Middlesex Hospital, the motion of the head has continued.

" There is a perpetual rolling of her head night and day. It was first noticed whilst she was in bed, by a patient who lay near her. The head turns twenty-two times in the minute. The action producing this rolling motion is in the sterno-cleido mastoideus, trapezius, and splenius muscles, first of the one side and then of the other, so as to move the head on the tooth of the dentata as regularly as if it were swung round by a pendulum; and this continues night and day. Her breathing appears to be perfectly easy; there is deafness in the right ear, and a degree of lassitude in the right side."

This young woman continued an object of interest for some months, her complaint being principally referred to her stomach. She was at length seized with an attack of hæmorrhage from the lungs. She was repeatedly bled, and consequently reduced low, and became hysterical.

But what was remarkable, was the amendment of this motion in the head under the general debility. The motions became quicker, and the rotation to a less extent, like the diminished oscillation of the pendulum, from being shortened; and when in bed asleep, the motion ceased. Another attack of hæmoptysis succeeded; but, notwithstanding, the affection of the muscles of her neck diminished. She was made an out-patient; and in a few days after I saw her visiting her old friends in the hospital, entirely free of the unnatural motion of the head which had so long distressed her, and in high spirits.

It has been observed, that in this case the spasmodic motion reached the muscles on the side of her neck, and that there was a weakness of one side. I am not, therefore, authorized to affirm that the complaint was seated in the accessory nerve; nevertheless, it is my belief that it was so, and that it is the susceptibility of this nerve which makes the sterno-cleido mastoideus muscle so frequently the seat of those deranged actions.

No. CLXI.—*Spasmodic Contortion of the Head and Neck.*

Mary Preston, aged 19.—This young woman was brought from the physicians' ward into mine, that I might have more frequent opportunities of studying her case.

" The sterno-cleido mastoideus, and the trapezius of the left side, are subject to almost continual actions, which twist her down to that side; the ear is brought near to the shoulder, the head turned round, and the chin pitched up, whilst the shoulder is elevated, and the body bent. These violent actions are attended with considerable pain.

" The actions of the muscles are not constant nor regular. The violent contractions come at intervals. The sterno-cleido mastoideus first comes into action, drawing the head forwards and downwards; then comes the trapezius, twisting the upper part of the trunk, and carrying the shoulder to the ear.

" This has continued with longer or shorter intervals, about eighteen months. It began by slight degrees. She first perceived that she had a drawing of the head towards the shoulder, with little pain, and slight inconvenience. Previous to this attack she had been delivered, after a severe and protracted labour. She is now obliged to support her head with her hands, otherwise it is drawn completely down to the shoulder. She complains of pain in the head, which is attributed to the continual action of the two muscles."

I am often obliged to cease conversing with her, and to draw off the pupils from the ward, seeing that her anxiety increases the violence of the spasm. I ordered to this patient a soft-stuffed collar, to be put round the neck, on which I hoped the head might rest, and save her from the necessity of carrying her head, as it were, continually in her hands, which was a thing painful to witness. But no support or control by bandage could be borne.

When first brought into the surgeon's ward, she was found to have scarlatina; after this I thought I had got some indication, in her vomiting three *lumbrici*. After a course of worm medicine, she had an attack of continued fever; and it was necessary, in her debilitated state of health, to send her out of the hospital.*

---

* *Obstipitas lateralis.* Musculi sterno-mastoidei dextri strictura, Boerhaave, Consult page 220. Tulpii. lib. 4. cap. 57. Boneti. Mercur. Compil. page 130.

" Syndicus Genevensis sexagenarius, vir rebus publicis diu intentus, incidit in obstipitatem lateralem: caput ipsi, vellet nollet, dextrorsum vertebatur, sine inclinatione, adeoque ab oppositi lateris sterno-mastoideo musculo trahebatur fortius et ad antagonista debilius: in utro horum foret vitium roboris aucti vel imminuti, vix cognosci poterat, nec tensio alterutrius musculi id satis indicabat. Præscripta incassum multa remedia ut apud nos aquarum thermalium affusio, suaserat Boerhaave sequentia, 1°, delapsum aquæ calidæ in nudum caput mane et vespere ad septem minutorum spatium quotidie per sex septimas cum frictionibus moderatis: post has embrochas: 2°, locum dextri musculi sterno-mastoidei mane et vespere inungendum diu unquento althææ composito:

Is it too much to ascribe the affection of these muscles to their strain in the act of delivery? Nerves are over exerted by violent actions, as much as muscles are overstrained. I have known the shoulder of a little girl fall quite down, in a temporary palsy of the muscles which support it; and in that case it was presumed to be owing to an over-strain. We are quite in the dark as to the particular nature of the disturbance in the nerve. Apparently from the same cause, we see a class of muscles become suddenly paralytic, or subject to occasional twitchings, or to violent and continual actions, by which they are inordinately increased in strength.

I think the cause of the obscurity in these cases will be apparent to the reader. It is not the muscle properly which is diseased, but the nerves: and it is not all the nerves of the muscle, but only one class, which is the reason why the muscle is so strangely and spasmodically contracted, whilst it is still under the influence of the symmetrical voluntary nerves. The muscle being an engine moved by two distinct powers, and one of these only being deranged, is the cause of the difficulty in comprehending the case.

The practice advised in the foot-note on the preceding page is not to be thought of. The intelligent reader will perceive the difference between this affection of the accessory nerve and the disease of the sterno-cleido-mastoideus, for which an operation is advised by modern surgeons, and that without these studies the diagnosis will be difficult.

No. CLXII.—*Case of Affection of the Respiratory Nerves on the Side of the Chest.*

Physicians' Ward, March 1824.

——— æt. 50.—We have not met with a more distinct case of affection of the respiratory nerves of the side, than is now presented to us in this patient. The following is a description of his condition:

"If he attempt to lie upon his left side in bed, his head is lifted from the pillow by a rapid succession of contractions of the muscles upon the right side of his neck and right side of his thorax; so that, instead of ly-

3°, totam plagam sinistri seu antagonistæ eodem tempore fortiter confricandum pannis siccis, succini accenso fumi penetratis, ut ejus robur invalescens parum faceret æquilibrio cum antagonista obtinendo.

" *Obstipitas spasmodica.* Boneti. Lorry de Melanch. p. 115. [Læsionis artificialis sanitatis exemplum ad producendam integritatem ejusdem est in descissione artificiali musculi sani ut par sit læso, et contractio cesset. Quod è chirurgis et suadetur et fit.]

" Parochus quinquaginarius, ab studio acriori, incidit in motus spasmodicos alternos et laterales capitis, quos reprimere vel suspendere vix poterat interdiu, caput in latus inclinatum manu sustinendo, sed noctu somno urgente compescebantur. Morbus per plures menses perseverabat cum præscripserim fomenta emollientia, occipiti applicanda, nam convellebantur musculi, qui a parte colli postica ad caput tendunt: præscripsi etiam narcotica, juscula pulli, dein lac asininum, balnea domestica, etc. a quibus melius habuit."—*Sauvages.*

ing at rest, his head and shoulders are raised from the pillow, and the upper part of his body forms a curve. These contractions are attended with pain, and this pain he cannot otherwise describe than by saying it is like a cramp. When he lies upon his right side he is more at rest, the weight of his head and shoulders counteracting the contraction of the muscles, and keeping him in some degree steady. On being asked whether these contractions disturb him during his sleep, he says he is sensible of their diminution as he is dropping asleep. When he sits up, the head is gradually drawn to the right side, and there is an obvious contraction of the right side of his neck. The sterno-cleido-mastoideus swells, and the trapezius is very distinctly in action; so that the ear is drawn to the shoulder, and the whole body becomes bent, and the head approaches to the side. In this state the pain he suffers is seated behind the mastoid process and at the acromion scapulæ, that is, at the origin and insertion of the sterno-cleido-mastoideus muscle and the insertion of the trapezius. He complains also of the pain and spasm striking from his back to the scrobiculus cordis, as if the diaphragm were affected. He also complains of a pain which is seated in what he calls his 'swallow;' that is, a spasmodic affection of the throat accompanies the affection of the external muscles, but he has no impediment in swallowing.

"When we say to him, 'What, sir, cannot you hold up your head at all?" he makes an exertion and sits upright, suppressing his breath. But when he speaks his head begins to descend towards the right side by a succession of little movements, until he is quite bent down as before described. When we attempt to hold his head towards the left side, we see the sterno-cleido-mastoideus in violent action on the right side, and the muscles of that side are so powerful as to overcome us. When we hold the head down to the right side, he can pull against us with the muscles of the left side: he has the voluntary power of these entire, but they are not so strong as the muscles of the right side; it appears that by use the muscles of the right side have acquired great volume and strength. At first one might imagine that there was paralysis of the muscles on the left side. But we find that it is not the ordinary contraction of the muscles of the right side of which he complains, but of a violent spasmodic and painful action. That there is no paralysis, is obvious from this, that he can move his head to either side, twist round his mouth either towards his left or his right ear, turn his head in any way you choose, and raise his right or his left arm equally, throwing them over his head: all these motions he can perform when the spasm is not upon him. When it does come on, then the muscles of the right side only are affected with contractions, and those of the left side are perfectly relaxed.

"Twenty months ago, he says, he was raising a crow-bar, and he felt something snap at the upper and back part of his neck (and he puts his finger to the posterior insertion of the sterno-cleido-mastoid muscle). He does not say, however, that he felt pain at that time. A month after this he began to have pain, and still he points to the same place, the back part of the mastoid process. The pain has gradually increased with the violence of the contractions; and, as we before said, the pain is like that of a cramp, and there is no pain in the intervals of spasmodic action."

Although the source of this complaint be obscure, yet it is a stage in the inquiry to ascertain that the spasmodic contractions are confined to the influence of the respiratory nerves of the trunk of one side. And indeed without the preceding account of the nervous system, the contractions here contemplated must have remained among the very great variety of nervous symptoms, which, owing to our indolence, are yet presented to us as mere accidents of nature which it is not expected we should investigate. It would appear that this man's condition has been produced by the violence of exertion. We have learned that, in violent efforts to lift weights, the muscles of inspiration are brought into aid of the merely voluntary act; and I have many cases to shew that violent exertion or long excitement of nerves, and continued exertion of particular classes of muscles, are followed sometimes with paralysis, and sometimes with irregular minute spasmodic contractions, which are very distressing.

No. CLXIII.—*Spasmodic Action in the Sterno-cleido-mastoideus and Trapezius Muscles.*

Mr D., a farmer, fifty-eight years of age.—The first appearance of this patient was characteristic. He walked past me to the further corner of the room, and standing there upright, and with his head as it were forced into the corner, he began to speak to me. He said his complaint commenced with a lowness of spirits, accompanied with a pain and weight at the back of the head, and down the shoulders; and this he particularly felt when riding on horseback. At this early stage his head was not pulled down, although his friends observed that it was a little awry. This was four years ago; it is about a year since he began to feel the pulling upon his head. He feels now as if a weight pulled it down; and to keep himself tolerably easy he must hold his head with both his hands. When he sits upon a chair he throws his head over the back of it, in such a manner as to make the weight of it counteract the pulling on the muscles of the neck. When he stands up and allows the muscles to have their influence, the occiput is turned to the right shoulder, and drawn down to it; and of course if you are standing before him, you see his profile with the chin to the left shoulder, and pitched up. He has pain, especially in walking, across the ribs on the right side, and this is attended with a catching and shortness of breath; and he describes it by saying, it is hard work walking; and he draws his fingers along the attachments of the serratus magnus to the ribs.

If you put your hand broad upon the side of the neck whilst the head is pulled down, you feel a powerful action in the trapezius muscle. The sterno-cleido-mastoideus is also in powerful action, that is to say, the sternal portion of it; and a strong cord of the trapezius, and of this anterior portion of the mastoideus, may be felt as they act in rapid succession, rolling the head in a singular manner, at the same time that it is pulled down. He complains of a pain just under the tubercle of the occiput, and on the ligamentum nuchæ. He describes a sensation of catching on the left side of his face.

When he coughs, there is neither increase nor diminution of the spasms. Being asked as to this point, he observes, however, that on the moment of swallowing a morsel, the pulling of the neck is brought on. When fatigued, he rises and stands in his present position, with his head and left shoulder resting against the wall, his feet at some distance from the wall, and his heels off the ground; and thus his body forms an arch from the feet to the shoulder. This patient was attended by Mr Heelis of Limehouse.

No. CLXIV.—*Spasmodic Action in the Sterno-cleido-mastoideus and Trapezius Muscles.*

——— This gentleman is distressed with a spasmodic affection of the side of the neck. By the death of a relation he was involved in harassing family disputes, under which he is sensible his mind has suffered. Although enjoying good health, he has been subject to bilious attacks, and has had a discharge from his left ear.

When coming into the room he presents exactly the same appearance as the farmer who lately left me. He supports his head with his hand, and seeks relief as soon as possible by propping his head against the wall, or by letting it fall over the back of the chair, supporting the occiput with the hand. He complains that his face is forcibly drawn round to his shoulder. His sterno-cleido-mastoideus muscle, during this state of constraint, is as hard as a board; but when the paroxysm is at the worst, and when the mastoid process is drawn towards the sternum, he can by volition, and in a temporary manner, relax the muscle and poise the head equally; but this is for a short time only; the incontrollable action of the muscle returns and drags down the head, twisting the face to the left side, and pitching up the chin. A rigidity of the right side of the neck, attributable to the lateral portion of the trapezius, shews that that muscle partakes of the spasmodic action. There is no complaint of the side of the chest, nor difficulty of breathing. The agitation of riding over the stones makes him worse. When he is lying down, and when his head is propped with pillows, it remains almost quite still. The pain in the back of the neck appears to be rather the effect of continued exertion than of any thing inflammatory. When the paroxysm is severe, the convulsion extends to the muscles of the larynx, and he makes attempts as if it were to get rid of something which was producing a huskiness in his voice. When he supports his head and is at rest, the act of drinking brings on the paroxysm.

He is at perfect rest only when he is asleep.

No. CLXV.—*Case communicated by Mr Alexander Shaw.*

" Thomas Brown, æt. 58, a shoemaker in Ayr, has suffered for nearly three years from a spasmodic affection of the muscles of the neck and shoulder. A year or more previous to his being attacked with this complaint, his health became broken, which he says was owing to his being addicted to drinking, and reduced to a state of great poverty. He first perceived a stiffness on one side of his neck; he had also a weakness in the left half of his body, but he did not lose the command over the parts thus affected. The spasms in the neck came on suddenly, and they were at the beginning very nearly of the same kind as they are now.

" During each of these spasms his head is drawn down gradually, and by successive actions, so that the left side of his face comes almost in contact with his shoulder; but there is, in addition, a rotatory motion of the head, by which the chin is turned round and tilted obliquely upwards, towards the opposite side. His head is thrown back on the nape of his neck, his mouth is drawn open, and the whole of the left side of his face is twitched with a succession of frequent convulsions; the shoulder on the same side is elevated, and the arm is thrown forwards across the body when the head is thus drawn down. These spasms are repeated ten or fifteen times in the course of a minute. At intervals during the day the same paroxysms come on with increased severity. Then the convulsions of the face and neck are of the most violent kind: his arm and shoulder are shaken backwards and forwards with a kind of shrugging motion, and with amazing rapidity, so that the whole body partakes of the tremor. While these very severe fits last, which is for about a minute each time, his breathing is performed with difficulty, and he gasps as if he were suffocating; altogether he appears as if he were submitting to the most extreme suffering. During the course of the day he is attacked frequently with these violent paroxysms, but he cannot assign any reason for their being brought on at one time more than another.

" On examining him when the usual spasms were taking place, the left sterno-cleido-mastoid muscle was distinctly larger and more prominent than the other; and it became hard and round when the spasms occurred. The anterior fibres of the trapezius were likewise firmly contracted when the spasms took place, but the condition of this muscle was not so easily ascertained as that of the other.

" He has a constant pain in the left side of his neck, principally seated at the mastoid process of the temporal bone, but extending also along the course of the clavicle. He said it was long before he fell asleep at night, owing to his head shaking against the pillow. When asleep, his friends have told him that his head lies perfectly still; and he expresses the regret which he feels each morning when he awakes, being conscious that his sufferings were immediately to begin again. He is able to walk about the town. Various remedies have at different times been tried, but without producing any perceptible benefit."

No. CLXVI.—*A Case of Spasmodic Affection of the Neck. A Communication.*

"Francis Barney, a healthy man, twenty-seven years of age, by trade a blacksmith, was, in February last, seized, without previous illness, with a spasmodic contraction of the muscles of the neck. The spasms were slight for a few weeks, but they have since been severe and frequent, though not permanent. During the contraction, the face is forcibly drawn to the left side; and it would seem, that the clavicular portion of the sterno-cleido-mastoideus is alone affected, or at least more especially. To give some idea of the violence of the spasms, I only need say, that all the power a strong man can exert is insufficient to counteract them. Although this spasmodic affection has now continued for nine months, without any material alteration, the patient's general health does not appear to have suffered. He was not under my care until July, but from the gentlemen who attended him I am informed, that the treatment in the first instance consisted of general and local bleeding, free purgation, afterwards mercury, followed by antispasmodic stimulants of turpentine, &c.; irritating applications had also been applied to the antagonist muscle, with the hope of exciting a stronger action, and counteracting the spasm of its opponent. I have never thought this spasm owing to a want of power in the antagonist muscle, but have rather apprehended that it depended upon an affection of the accessory nerve, and had consequently no great expectation from medical treatment; but having witnessed decidedly good effects from strychnine in partial paralysis, I thought it deserved a trial in this intractable case; it was therefore prescribed; at the same time a large seton was inserted in the neck. The strychnine was continued for a month in full doses, producing its usual effect, but no real benefit. He afterwards became a patient in an infirmary, where he derived no advantage whatever. Some attempt has since been made to keep the head steady by mechanical means."

No. CLXVII.

Miss C., æt. 30, attended by Dr Miller of Exeter and Mr Croker of Chudleigh.—She has been subject to headach, which has left numbness of the face. Complains of numbness of the right arm and shoulder,—straightness of the muscles of the right side of the neck,—involuntary motions of the head from the right side to the left,—"no resting place for her head." "She has a sensation as if an iron net-work between the skin and skull bound down the head." "No headach such as she is accustomed to when well." (She is clever, and possesses great vivacity.) Her sister with all her strength cannot control the motion; but when she herself unconsciously makes an effort, especially looking upwards, she succeeds.

No. CLXVIII.—*Case of Wry Neck.*

"*Sheffield, June* 27. 1829.

"SIR,—About December 1827, Master ——— was seized during the night with a stiff neck; it excited little attention; he played with his schoolfellows as usual, some of whom playfully, but rather rudely, twisted his head in a contrary direction. When he returned home at the Christmas holidays, I was requested to see him. I found his general health very much deranged, and his sterno-cleido-mastoideus muscle on the right side rigidly contracted. Leeches and fomentations were applied to the mastoid extremity of the muscle; alterative medicines were prescribed; strict attention was paid to the bowels; and after some weeks his general health very much improved: still the muscle remained as rigid as ever. During the summer, his father took him to London, and you were consulted. I believe he was advised to go to the sea, and a steel apparatus was recommended. The sea, I understood, was of service to him; but as the apparatus did not improve his neck, and injured his back, it was, after some weeks' trial, laid aside. A vigorous system of shampooing was then adopted, together with very active exercises. His health improved; he grew taller, and stouter; and by a great effort he could stand straight: but the moment he relaxed his efforts, his chin turned towards his shoulder, his spine became curved, and he relieved himself by resting on one leg.

"All remedial measures were at length abandoned, and this last half year he was sent to school. His general health has continued good, but his sterno-cleido-mastoideus is just as it was.

"Mr ——— has requested me to correspond with you respecting his son. I presume, to learn whether, from my description, and your notes or recollection, you have any further plan to propose. Whether you would recommend any division of the muscle, or whether, before giving any further opinion respecting him, you would wish to see him. In the latter case, I believe his father would immediately take him to London.

"I am, Sir, respectfully yours,

"ARNOLD KNIGHT, M. D."

This young gentleman is gradually improving by shampooing and proper exercises, which put the muscle on the stretch.

CLINICAL OBSERVATIONS.

No. CLXIX.

The wry neck is a different complaint from these spasmodic affections of the mastoid muscle.

Note.—Sir —— —— has been brought to me under the idea that he had disease of the spine, but from his appearance in coming into the room, I saw that the character of the distortion was entirely different from that produced by disease or weakness of the spine. I soon discovered that his manner of holding his head was not a habit, as the family supposed, but an inevitable consequence of the state of the sternal portion of the mastoid muscle. The head is inclined to the left shoulder as if it were unequally drawn, or had fallen, from the paralysis of the muscles of the opposite side; the ear is twisted to the shoulder, the chin pitched up, and the shoulder of the affected side is higher than the other. This appearance immediately drew my attention to the sterno-cleido-mastoideus muscle, when I found that the portion of it which runs from the sternum to the mastoid process was as firm and unyielding as a cord, and checked the movements of the head.

The distortion of the neck and shoulder arose from the accommodation of the vertebræ to the state of the mastoid muscle; and from the same cause arose the inequality of the shoulders, since the rigidity and shortness of the sternal portion of the muscle was in part relieved by the elevated position of the clavicle, just as by the depression of the mastoid process.

This disease is a degeneration of the fibres of the muscle into a tendinous texture. It is relieved, however, by proper exercises and the shampooing of the muscle. When the muscle has quite degenerated, the tendon may be divided.

On these cases of spasmodic contraction of the neck and shoulder I prepared the following note for clinical lecture.

You have in the wards a remarkable instance of contraction of the muscles of the neck. The young woman is supposed to have a disease of the shoulder joint. But there is no proof of this. The shoulder is drawn up to the ear, and the muscles are spasmodically in action.

The other case is that of an elderly woman, who exhibits the unhappy effect of a spasmodic action of the muscles on the side of the neck, in causing an incessant motion of the head, such as in former days I have seen in a gold head of Boerhaave moved by clock-work over an apothecary shop door, rolling continually from side to side. It ceases when she falls asleep.

Now the question arises, Can the anatomy assist us here? Can we give any account of the relation between the parts primarily affected and those signs of irritation?

I cannot resist the belief that the relation is established in the body, not in the brain. When a man is decapitated, and when after this, galvanism is applied to the spinal marrow, the body is not universally and equally convulsed, but certain *actions* are performed—horrid grimaces, motions of the limbs, &c. For my own part I like to draw my inferences from established facts rather than experiments. Observe the nackers (the men who kill horses and provide dogs' meat), when they have knocked down the animal, they do not begin to flay, but pass a rod down the tube of the spine; for if they neglect this they are subject to be kicked! the irritation of their operation excites the nerves of sensibility, and the concatenation of muscles being complete through their nerves, though the office of the brain is gone, the animals strike out with their heels!

If there be such a union of sensation and motion, is it not established in the spinal marrow? and if so, does it not imply that the irritation of certain parts will induce the contraction of certain muscles? This gives interest to anatomical inquiry. It makes us dissatisfied with that eternal answer in the mouths of the indolent, "It is hysterical." By this term I apprehend a mobile condition of the female system induced by uterine irritation. The immediate cause of the spasm may have the same source, or it may have a different and superadded cause. In the former case, the action is confined to the *sterno-cleido-mastoideus*, a muscle of respiration; and the irritation may be in the lungs, or heart, or stomach. We are familiar with external pains proceeding from these sources; why not then spasms of the muscles directly concerned with their functions?

I should not be authorized to draw this conclusion from a solitary case; but these are frequent in my practice, and I pursue the irritation from the slightest spasms of the face to the contractions of the serrati on the side of the chest, drawing the body down almost to the ground.

From this view of the pathology we have two things to attend to; 1st, To correct that susceptible condition of the whole system which may be considered hysterical; and in the 2d place, To discover the particular irritation. We may suspect the stomach, and give such remedies as relieve a painful state of this organ; or we may take it as allied to an asthmatic condition, and relieve the sensation from the bronchi.

On one occasion I certainly removed the spasmodic action of the sterno-cleido-mastoideus, by attention to the stomach, and using the subnitrate of bismuth.

No. CLXX.

The following case will illustrate the distinction between the respiratory and voluntary nerves:

Mr ——, surgeon, and a West Indian, called upon me to hold some conversation on his own case. He attributed his unhappy condition to a malignant fever, with erysipelas, during which there had been exhibited a great deal of calomel, as much as thirty grains at one dose, which cured him; but he thought it left him subject to a gastric affection, with chronic inflammation.

However that may be, this is his present condition. On falling asleep, just at the moment when volition and sensibility cease, the involuntary motions also stop, with a sensation of death, under which he awakes generally convulsed.

His medical friends have sat by him and watched him, and they have found that when sleep is overpowering him, the breathing becomes slower and weaker, the heart and pulse also fall low, and cease to beat as sleep comes on, and after a short time he awakes in terror.

This gentleman is very naturally in much apprehension that some of these attacks may terminate existence. But he is young, and I think the attack is essentially different from the case of angina pectoris. The case presents to us a lively idea of what would result, were the involuntary nerves subjected to the same law with the nerves of sense and volition, for then sleep, by overpowering both, would be death!

No. CLXXI.—*Note additional to the Cases of Affection of the Nerves of Respiration. Extract from MS. Notes of Mr Hunter's Lectures.*

"Mr Hunter observed, that he had the gout in his feet two successive springs: in the third he missed it; but on a sudden he felt a peculiar hard pain about the pylorus. This was attended with great weakness; and having accidentally cast his eyes to a looking-glass, he fancied that his countenance was like that of a dead man. He could feel no pulse in either of the wrists. Finding the involuntary respiration ceasing, and fearing that he should die in consequence, he imitated the involuntary, by a voluntary action of the muscles, and breathed altogether by force, as well as he could. As physic could be had for nothing, he soon found himself surrounded by physicians from every quarter, who attempted to feel his pulse to no purpose, any more than the pulsation of the heart. In this situation he continued a long while, perfectly sensible, swallowing a number of hot things according to custom, but he believed to no purpose. He attributed his gradual recovery to the operation of nature. Probably as his blood did not circulate, it was not necessary for him to breathe. Here was a suspension of the most material involuntary actions while the voluntary actions continued."

No. CLXXII.

Lady P. (after great mental suffering, and I believe the death of her husband) has a singular pain produced on inspiring. She first experienced it on smelling a rose. She was seized with a fit of sneezing, attended with pain, like an electric shock, down the shoulder, elbow, and arm, followed by a sensation of trickling down the arm, with what she calls sleepiness of the arm. These symptoms return on sneezing, hemming, or coughing; she especially dreads sneezing.

There is now pain and exquisite tenderness in the points of the fingers, and a feeling like sand interposed between the fingers and any thing she touches.

No. CLXXIII.

A gentleman consulted me with a very singular complaint. I prescribed for him; but being much engaged, Mr A. Shaw took the case, with his usual care and judgment. He published it in the Medical Gazette, of which this is an abstract.

Oct. 28.—This gentleman is 28 years of age, of an active and athletic form. He complains that he cannot expand his chest freely in taking a full breath. Upon stripping himself, it is found that his ribs, and especially the lower margin of the chest, are drawn inward, or constricted in a remarkable manner; so that the waist presents the same tightened appearance that might be produced by drawing a bandage firmly around it. In correspondence with this constriction of the thorax, there is a fulness and rotundity of belly like the pot-belly of an old person. This constriction of the chest continues equally in inspiration and expiration. When he is requested to draw a deep breath, the ribs remain motionless; the thorax is neither elevated nor dilated in a sensible degree. His breath is checked before the full inspiration is accomplished, and the stomach or great intestine is protruded with a rumbling noise.

The muscles which act in dilating the chest were examined with great care. When the hand was pressed hard against the serratus magnus, no action could be perceived; and the same want of action in the sterno-mastoidei was remarked. The shoulders were not in the slightest degree elevated, although the patient endeavoured to imitate the usual action of heaving the chest.

On the other hand, when the abdominal muscles were felt, they were found to be in powerful action during each expiration, and the fibres of the rectus started into view; and on pressing the belly more firmly with the hand the patient starts back, saying that the pressure there prevented him breathing.

A pinch of snuff, by exciting sneezing, causes pain: he says the act of sneezing "is divided into a succession of short imperfect fits, during which the part about the waist seems to be tearing separate."

He is disturbed with frightful dreams, and wakes with a sense of suffocation. He stops in walking up a hill; his speech is not affected, but he cannot read aloud for any time; and in singing, his natural power of voice is diminished.

The muscles of the neck and chest are stationary in respiration, but retain their free action in the voluntary motions of the frame.

This is the fifth time that he has been similarly attacked: the affection has generally lasted for a fortnight: he was first seized while gallopping his horse on the beach near Liverpool: he then felt a sudden difficulty of breathing, which made him exclaim to those riding with him that he "had lost his wind." This occurred shortly after he had recovered from a severe attack of inflammation of the bowels. He himself attributes the subsequent attacks to the effects of living at the sea-side; for it has been only when residing at the sea that he has been seized with the complaint. He has just returned from Liverpool, to which place he had gone, in perfect health, not more than a week ago.

He points to the looseness of his waistcoat, under which he can thrust his two fists, as a proof that he is naturally broad chested.

It was not many days before he presented himself again, to announce that he was quite well. A comparison was now made of the measurements of his chest, which had previously been taken, with those in his present sound condition; and it was found that in the upper measurement, which was at the nipple, his chest had expanded two inches; and at the lower one, which was at the ensiform cartilage, it had expanded five inches.

Extract from the Patient's Letter,—After leaving you in November I returned into Yorkshire, daily improving, my chest assuming its natural form, and being enabled to expand it at will. Of course, with so favourable a change, I felt stronger, and more able to bear fatigue. So great an improvement in my state of health induced me ten days since to try Liverpool. In twelve hours my chest entirely fell, and became more contracted than when I was in London. I am now suffering the greatest pain, through the region of the heart to the left shoulder-blade. I breathe from the stomach, having again become pot-bellied, as stated by Mr Shaw in the Medical Gazette. In attempting to raise or expand my chest, the left side and lower ribs are drawn spasmodically together. In addition, there is great fulness in my head, and great languor and prostration of strength.

To guard against the worst, I used the sponging with vinegar and water. I then applied the opium and belladonna plaster, and took the draught with idiorate of iron. But the enemy had too strong a hold of me. My hopes of relief are in leaving this place for a midland county, and there taking your medicines.

No. CLXXIV.

In hemiplegia we sometimes find the respiratory nerves affected; but I may say they preserve their peculiarity of action.

[Note-book, 5th Feb. 1835.] This young gentleman's hemiplegia began like some others with a numbness in the extremity of the middle finger, which he bit to restore it to feeling. After taking a bath at night, he found in the morning his hand closed and his leg weak. Whilst he lay he could speak, but the moment he took the erect posture he lost all power of utterance.

On a second attack he awoke in convulsions and crying; but was seized with an irresistible propensity to laugh, and although of a serious turn of mind, he could not go to church "from his irresistible propensity to laugh from the Lord's prayer to the end of the sermon."

CLXXV.

There is at this date a young woman in the hospital with an obstinate contraction of the *tibialis anticus* muscle, which draws up her foot into the shape of the club-foot of children. At one time the spasm in the leg became more general, drawing her thigh up to the abdomen with severe pain. This young woman was relieved, and dismissed, and has just returned to the hospital with her great toe permanently dislocated.

No. CLXXIV.

I had a young girl during the last season with a more extrordinary contraction; the whole limb was so spasmodically affected in all the flexor muscles as to endanger the ligament of the knee-joint, and her great toe lay close to the anus. The limb continued thus fixed and rigid, but at length yielded entirely. The limb had for some time assumed the position of hip disease, and she had been treated with issues to the hip.

These attacks sometimes become permanent, and lay the foundation of disorganization.

No. CLXXVII.

Miss G——, a lady of fortune, has her feet distorted by a powerful action of the *flexors* and *tibialis anticus* of both legs. She is not conscious of this contraction unless by the pain of resistance to the position of the feet. The *glutei* muscles are wasted. The feet and extremities are tolerably pliant whilst she is in the horizontal position; but the instant that she is in the erect position the spasm comes on, and her toes are pointed to the floor. This condition has continued for six years. It has been treated as a disease of the spine.

Partial Wasting of the Muscles of the Extremities.

This is an obscure subject, but there is a circumstance which I have observed so often in examining patients thus afflicted that I must note it down. The paralysis does not extend to a part of the arm or leg: nor is it a defect reaching so far up the limb or so far down the limb, but it is an affection of the muscles which are naturally combined in action: although these muscles be in different parts of the extremity, and are supplied by different nerves as they are by different arteries. For example, the muscles of the thumb may be affected: but then the wasting will not be confined to the short muscles of the ball of the thumb, but will extend to those muscles of the thumb which lie upon the fore-arm; and these wasted muscles are seen lying in contact with others which are plump and powerful. Or sometimes all the extensor muscles will lose their power, while their opponents preserve it, producing a characteristic position of the limb. It will sometimes happen that, one class of muscles having suffered, another class will come into play, and be developed by unusual exercise. I have found the action necessary for writing gone, or the motions so irregular as to make the letters be written zig-zag, whilst the power of strongly moving the arm, or fencing, remained.

No. CLXXVIII.—*Wasting of the Muscles of the Thumb.*

Smith, æt. 22, an ironmonger.—A year and a half ago he was suddenly deprived of the use of his right thumb. The right arm, and indeed the muscles of the whole body, retain their power; even the abductor muscle of the thumb has its proper action: but the adductor, flexor brevis, opponens, that is, the muscles which form the ball of the thumb, are wasted; so that you feel the bones and the strings of tendons over them. When a comparison is made between the long extensors of the thumb on both the arms, those of the right appear to be considerably wasted, and they want the rigidity which belongs to those of the left arm; yet the tendons start out when he brings these muscles into action. He has been employed in serving out the goods in an ironmonger's shop, and has never had any thing to do with the severe work of manufacturing: he has not at any time worked much with lead or with any paints: he has had no affection of the bowels that he can recollect: he has never had any complaint to denote an affection of the brain, nor any pain in the course of the nerves.

No. CLXXIX.

I was consulted during the last year by the parents of a young gentleman, fifteen years of age, in whom this paralysis of particular muscles, and consequent wasting of them, was very distinct. In my note of the case it is stated, that two years before visiting me he had scarlet fever, attended with sore throat and delirium, for eight or ten days. It was after this fever that his right arm was first perceived to be weak. Subsequently the left arm became weak, and this muscular debility increased without any pain or apparent disturbance of his general health.

The muscles of the thumb are not wasted, and the flexor muscles of the wrist and fingers are powerful; he can grasp his father's hand so as to make him cry out. Yet the extensors of the wrists and of the fingers are weak, so that the hand remains generally bent, and at an angle with the arm. Whilst the fore-arm is firm to the feeling as you grasp it, the muscles of the arm are wasted and loose, and you can feel all the processes of the humerus, from its upper to its lower end: the deltoid muscle is also quite gone. The rotation and motion of the arm are very curiously performed by the muscles inserted into the scapula, which are firm and strong, so that the arm is thrown about by the rotation of the scapula upon the chest. The muscles which come down from the neck to the shoulder are particularly strong, and it is by them that the scapula is heaved up and a secondary kind of motion given to the arm. All the muscles which are for bracing down the scapulæ to the chest, and drawing them backwards, are wasted, and the inferior angles of both the scapulæ start out three inches from the ribs. It is astonishing with what energy he can fling his arms about, by those muscles alone which come from the neck to the shoulder: for example, he jerks on his coat, and draws it upon his back, solely by the action of the muscles of the neck; when undressed, he can swing his arms round and round; but it is by adjusting the action of raising the scapulæ with the gravitation of the upper extremity that he contrives to do this, and he seems to possess a more extensive influence on the muscles of the arm than he actually does. He is tall and is still growing fast.

On the 17th September, I was again visited by his mother, when she reported that his muscular strength had declined, particularly in the right leg, and that it required two men to place him on the seat of the carriage. His spirits are excellent; his remarks shrewd; and his education is proceeding: he has grown considerably.

The affections of particular muscles, or classes of muscles, imply a very partial disorder of the nerves. A disease of the brain, or a disease in the course of the nerve, must influence the whole limb, or that portion of it to which the nerve or nerves are distributed. But in these cases, particular subdivisions of the nerves, included in the same sheaths, or running the same course, are affected. I am inclined to attribute such partial defects to the influence of visceral irritation. In that case it must still be the influence of the sympathetic nerve which produces it; and yet, on the other hand, it seems impossible to account for such entire loss of motion without the intermediate influence of the brain.

No. CLXXX.—*Case of Partial Paralysis of the Lower Extremities.*

July 23d.—The consultation this morning is connected with this subject. The patient is a young gentleman about eighteen. All the muscles of the lower extremities, the hips, and the abdomen, are debilitated and wasted. The extensor quadriceps femoris of both limbs is wasted,

is an affection of the muscles which are natu equal degree. A firm
although these muscles be in different parts e-joint, marks the place of
plied by different nerves as they are by wasted and gone. He has
the muscles of the thumb may be affec emities. The upper part of the
be confined to the short muscles of ng. There is no defect percepti-
tend to those muscles of the thu or of the bowels. There is a slight
these wasted muscles are seen ly bar part of the spine. He is weak, and
and powerful. Or sometim g up stairs; his tongue is coated. Alto-
power, while their oppone very irregular. On some days his spirits are
sition of the limb. It w essed and unable to move. Much of this, he
having suffered, anoth citement or amusement, and very much on the
unusual exercise.
or the motions sc ility of the muscles came on gradually: he was first
whilst the pow public school, about eight years ago. It began with a
thighs, which disabled him from rising; and it is now
N ve how he will twist and jerk his body to throw himself
his seat. I use this expression, for it is a very different
Smit that of rising from the chair.
depri
mu
cl

XXI.—*Partial Wasting of the Muscles of both Upper Extremities.*

rton's Ward.—John Peterson, æt. 40, formerly a coal-heaver.—
man presents a remarkable example of the wasting of certain mus-
es: in the left arm it is partly the muscles of the fore-arm and hand
which have become wasted; while in the right, it is the muscles situated
around the shoulder joint and the flexors of the arm.

On attending more particularly to the affection of the left arm, it is found that, down to the elbow, the muscles are fully developed; but in the fore-arm, the flexors of the wrist and of the fingers, and the muscles which move the thumb, are wasted in a remarkable manner, while the extensors and supinators appear of their natural size. The muscles composing the ball of the thumb have been so completely removed by this process of wasting, that there is a marked depression between the metacarpal bones; and these bones are only loosely covered with skin. The outline of the ulna, where it is usually concealed by the flexor muscles, can be easily distinguished under the skin, in consequence of the thinness of the muscles. It is also remarked, that although the muscles on the outside of the arm are, to all appearance, of their natural dimensions, there is an exception with regard to the three muscles situated among them, which extend the thumb. It is quite obvious that these three long extensors of the thumb are reduced in size, in correspondence with those of the ball of the thumb. When he is directed to move the hand in different directions, it is observed that he possesses no power whatever over the thumb. He can only bend the wrist a very little; and as to the fingers, he can scarcely bend them in the slightest degree; yet although he is so deficient in those motions, he can extend the hand and wrist with considerable force when the fingers have been previously closed for him.

In the right upper extremity it is about the shoulder that the affection is situated. The first thing that strikes the eye is the exposed manner in which all the prominences of the bones composing the shoulder stand out, so that, although the patient is a robust and heavy man, this part has the appearance as if it belonged to a person reduced to the last stage of emaciation. The trapezius, the latissimus dorsi, and the other muscles which connect the scapula to the trunk, are full and fleshy; but the muscles which are lodged on the back of the scapula, viz. the supra and infra spinatus, and the deltoid, appear to be entirely wasted. It is the wasting of the latter muscle which principally causes the acromion, the coracoid process, and the head of the humerus, to be so distinctly seen under the skin. But there is likewise a remarkable appearance presented in the muscles of the arm: the biceps is wasted to such an extraordinary degree in all its length, that it is like a piece of thin cord extending down the arm from the shoulder to the elbow, over which the skin is folded loosely. Yet the triceps has the same massiveness and strength which belongs to a powerful man. The patient cannot raise his arm from his side, and all the motion that he can give to his shoulder is by swinging the arm by a motion of his body. Although he cannot bend the elbow, he can straighten it forcibly. His usual position is characteristic of the affection of the muscles: he is commonly seen with the right arm bent before his breast, and supported by the left fore-arm. He is enabled to support the right arm in this manner, from the muscles of the left arm being perfect as far down as to the upper part of the fore-arm; and when he holds the right arm in this position, he can use the hand as he pleases, since the affection of the muscles of the right arm does not reach beyond the insertion of the biceps.

The complaint began three years ago, when he appeared to be in good health. He first experienced a pain in the left arm, which darted from his shoulder to his elbow, and made him forcibly extend his elbow. Then he perceived the fingers of this hand becoming weak, so that, when he was pulling a rope, they yielded to the slightest force. The wasting of the ball of the thumb was attended with a continual pain, which was occasionally aggravated so as to be very severe. He continued at work for eighteen months, that is, until his right shoulder became affected. The weakness of the right side also commenced with a sense of pain darting through the whole arm. Yet his health was not disturbed. For a month it continued only to be a slight degree of weakness, he felt he could not use the shoulder so perfectly as before: but at the end of this time, his arm suddenly dropped, he could not raise it from his side, and he has been disabled from working ever since.

He has had strychnine administered: he has just returned from Bath, where he was recommended to use the baths: he has been frequently cupped on the back of the neck; he has had a seton there: but he has derived no advantage from any of these measures.

He has never worked with metals or paints. He was originally a rope-maker; and when he became a coal-heaver his work was not of a severe kind. A. S.

No. CLXXXII.—*Case of Partial Wasting of the Muscles of the Upper Extremity.*

Oct. 1832.—J. Styles, a water-gilder, apparently in good health, and rather powerfully made, sought advice at the hospital for a weakness in his right arm. On examination, a remarkable contrast was presented in the plumpness or fleshiness of certain parts of his arm. The processes of the scapula are as distinctly visible as in the most emaciated body; and there is a corresponding wasting of the arm as far down as to the elbow. The muscles which are the most visibly affected, are the pectoralis major, the latissimus dorsi, the serratus magnus, the trapezius, the sterno-cleido-mastoideus, the deltoides, the biceps, and triceps. It appears as if the supra spinatus and infra spinatus, and the levator scapulæ and rhomboidei, retained their usual size, but this was doubtful. Although all these muscles are affected, in this remarkable manner, the fore-arm is that of a brawny muscular person. He cannot raise his arm from his side. When he makes the attempt the shoulder is elevated, as in the motion of shrugging. He can rotate the arm at the shoulder-joint in a trifling degree. He cannot bend the arm at the elbow. Although the muscles are very much shrunk in size, they do not appear to have lost the power of motion entirely.

This affection commenced ten months ago. He attributes the first attack to his having dipped the whole arm, while in a state of profuse perspiration, into a tub of very cold water, and kept it immersed for some time; after this, he had a trembling of the arm, which lasted for a fortnight, and then his arm dropt powerless by his side. He has never had rheumatism or pain in this arm. Although he has been occupied as a water-gilder for ten years, he has never had any severe illness, and does not think that his fellow-workmen are liable to partial paralysis or colic.

He has been electrified, and shampooed, and has had various remedies prescribed at different hospitals; but nothing has done him any good.

No. CLXXXIII.

A lady, whose husband was the English clergyman at St Helena, consulted me about her child, who had one leg much wasted in its growth. In conversing about the illness which preceded this affection in her little girl, she mentioned that an epidemic fever spread among all the children in the island about three or five years of age; and her child was ill of the same fever. It was afterwards discovered that all the children who had the fever, were similarly affected with a want of growth in some part of their body or limbs! This deserves to be inquired into.

These cases give proofs of the very partial manner in which the nerves may be affected. Not only do we see particular branches the seat of acute pains, but the muscles supplied by particular nerves or branches of nerves deprived of action; sometimes suddenly paralysed; sometimes deprived of their stimulus to growth, so that they dwindle and are absorbed! Not only a whole limb, or a whole nerve, or a whole branch of a nerve, is thus affected, but even certain muscles of a group will waste away.

In these circumstances, we can hardly attribute the cause to the brain; and if not to the brain, we must ascribe it to a direct influence of visceral irritation. We can sometimes trace the cause to the purging of a child on weaning; that is, to improper treatment, and food unsuitable to its condition. We sometimes can trace the source of it in violent spasmodic affections of the intestines in the adult. When the internal disease is violent, and the effects apparent, as in spasms of the calfs of the legs, we admit the proof of relation: But when the disorder of the abdominal viscera is less distinct, and nothing but habitual constipation is observed, the relation with the symptom in the extremity,—pain or spasm, or paralysis,—is less willingly admitted.

I am much mistaken if I have not prevented the permanent effect on the nerves of the extremities, by attention to the digestive organs early and perseveringly, and at the same time by exercising the muscles which were thrown out of action.

On the review of the whole class of symptoms, I believe these affections of the muscular system of the extremities, to have the same source with the affections of the muscles of the eye, which cause distortion and strabismus, viz. the union with the sympathetic system of nerves, and through that system with the bowels.

On the whole, the partial disorders of the nervous system give rise to a class of symptoms of the utmost importance for the practitioner to observe. I doubt whether dissection will afford us much assistance here. Pathologists stumble on the effects, and put them down as causes of the disease. There are many of those diseases which are preceded by no organic defect. Loss of power in the muscles, loss of sensation in the organs of sense, defects in the faculties of mind, take place without disorganization discoverable by the scalpel;* but if the patient lives, the consequences are, after death, visible in defective structure.

---

* The reader will be rewarded by reading a paper connected with this subject by Mr Alexander Shaw, on the successive development of the regions of the frame, and the interruption to the natural growth by rickets, &c.—*See the Medico-Chirurg. Transactions and Medical Gazette.*

No. CLXXXIV.—*Affection of the Voluntary Nerves.*

The most common instance of this is an impediment in speech, when the consent of the muscles is imperfect; but this sometimes extends to all the voluntary muscles of the body. I find that some are capable of lifting a heavy weight, or walking fifteen or twenty miles, and yet they have not the proper command of their limbs: there is an insecurity and want of confidence in the motions of the body, which overtakes them upon any excitement; a paralysis of the knees which prevents them from putting one leg before the other, and which endangers their falling. Thus a gentleman, capable of great bodily exertion, on going to hand a lady to the dining-room, will stagger like a drunken man; and in the streets any sudden noise, or occasion of getting quickly out of the way, will cause him to fall down, and in this manner a want of confidence produces a nervous excitement which increases the evil. With confidence, the power of volition acts sufficiently; there is neither defect of speech nor irresolution in the motion of the limbs when the person is at ease, or under a flow of spirits.

Such cases are very curious in their details, as exhibiting an extraordinary degree of incapacity for the affairs of life proceeding from slight defects. There is neither disease of mind nor of bodily organs; the corporeal frame is perfect; the nerves and muscles are capable of their functions and proper adjustments; the defect is in the imperfect exercise of the will, or in that secondary influence which the brain has over the relations established in the body.

No. CLXXXV.

Spasmodic actions of particular muscles are distressing, and sometimes ludicrous. Here is a musician who, being a fiddler, has been obliged to change his instrument, because the extensor muscles drew the bow off the strings of the violin. He can steady his arm to play upon the harp, by pressing his elbow to his side.

No. CLXXXVI.

——— Sometimes the peculiar motion of muscles is lost. For example: in this—a patient of Mr Hodgson of Birmingham—there is a weakness of the right arm which prevents him from doing certain things; yet his arm is strong when he exerts it against me in every direction; nor are the muscles wasted, although the affection has continued for six years.—"What motion, then, is it you cannot perform?" "I cannot use the paper-folder: I cannot fold a letter, so." I find that it is the motion of the wrist that is affected, *ulnad* as Dr Barclay would have said; that is, the combination of flexor, radialis, and ulnaris, although these muscles be powerful in their proper action of extension and flexion.

No. CLXXXVII.

——— He has lost the power of extension in his fingers. The loss of the extension of the thumb is frequent, but here the whole fingers fall together as when the hand is closed.

I have recommended a spring with cords going over the back of the hand, and dividing to the fingers. I got this idea from a musician, who by such an apparatus in similar circumstances, was enabled to resume his art. The play of the muscles is the most likely means of restoring their action.

No. CLXXXVIII.

——— Richmond, with Mr Julius. Our patient is a fine young woman, of twenty-six; dark hair; fine countenance; mother of four children.

The countenance on the left side handsome, and composed even when the right is singularly agitated. The right side of the face, upper and lower extremities, are agitated in an extraordinary manner.

She sits lightly covered in this excessive heat: her leg is suddenly drawn up; her elbow retracted, strikes against the chair; her hand is twisted, and her fingers play all sorts of fantastic motions. If she attempt to take a pencil or a spoon in her hand, it is jerked to a distance, and she picks it up again with the other hand. Her speech is impeded; her tongue is thrown out of her mouth in the effort like a dog lapping water.

These are distressing symptoms for friends to witness in such a person. Dr M. has called it "pressure on the brain." C. C. has countenanced the same notion. But pressure does not produce intolerance of light and rapid motion. There has been too much talk about an accident. It is the treatment, not the accident, which has brought her to this.

She was carrying a child and fell: she lay insensible for twenty minutes: repeatedly bled, and much reduced: three months after this accident she fell into this condition.

I advised affusion on the head; liniment with opium along the spine; draught with assafœtida and valerian; valerian and steel. Her recovery was complete.

No. CLXXXIX.—*Abridged Statement of the more Common Varieties of Paralysis.*

The Rev. Mr S. He is entirely deaf; would not hear a cannon close to his ear; paraplegia; the catheter is regularly used; is in danger of having sloughing in his hips; highly intellectual; supports his family by literary labours.

On examination after death, as it was reported by his medical attendant in the country, a considerable effusion of serum was found under the arachnoid membrane of the brain and in the spinal canal. The arachnoid membrane was thickened and opaque; the texture of the brain was somewhat firmer than usual, and its vessels more loaded with blood than is natural. It was forgotten to examine what was the condition of the ears that gave rise to the deafness.

No. CXC.

The Rev. J. S. Very deaf, but uses an ear-tube: carries a catheter in his pocket: he is feeble on his legs, and staggers in his walk: he thinks his mind affected, but he speaks and writes sensibly: the letters of a book appear in italics: sometimes sees double: he had a seton in his neck, which has been withdrawn on a carbuncle forming in his back. After five years this gentleman was rather improved than progressively worse.

No. CXCI.

——— a hearty old man, who talks of the excellence of his own beer! Complains of a numbness on all the left side. To be cupped to gain time: a smart purge after the blue pill: leeches to the hæmorrhoidal vessels; until by a better mode of life, the fulness of his vascular system shall be subdued.

No. CCXCII.

Captain G. Staggers into the room: defect of motion of the lower extremities: began six years ago with numbness in his toes, and has increased very gradually. He has great weakness in his knees; became aware of it by attempting to jump, when he fell. The arms are unaffected. He will not admit that there is any thing the matter with the head. He has not used the catheter, but he cannot command the bladder. The defect in walking causes him to walk on the outside of his feet; he cannot put the ball of the toe to the ground. With all this defect as to motion, he uses a singular expression to prove the sensibility of the skin; "he feels the touch of a lady's petticoat on the calf of his legs." Somewhat in contradiction he affirms, as a very curious circumstance, that at one time he could not tell the position of his feet without looking at them. Another peculiarity in this patient is, that he readily loses his balance on any rapid motion of his head.

No. CXCIII.

——— A continual shaking of the left arm: a little weakness of the whole of that side, of the neck as well as of the foot. There is no agitation in sleep, but as soon as consciousness comes, and the mind is active, the agitation commences. On relaxing the extensors by bending back the hand and fingers, there is no motion. I have recommended him to support the arms, &c. in order to give rest to the muscles.

No. CXCIV.

I had imagined something youthful, spirited, and elegant, in the authoress of H——. I found her old, wasted, shrunk up, and screaming in pain; a universal agony, accompanied with a certain degree of palsy. Some condition there must be, not yet ascertained, of the roots of the spinal nerves to cause this universal suffering!

No. CXCV.

Mr D. Has been an active man-of-business, and a most successful speculator. Eight years ago numbness began in his hands: first the right hand and down the right side; then the left side became affected, first the hand, and then the leg. At the same time he began to stoop, and now his back is bent like a bow, and his head projects forwards under the level of his shoulders. He drags his legs, and there is tremor of his hands.

But what most excites my attention in this poor gentleman is the incessant call to run or walk across the apartment. A servant attends him by day, another by night. He cannot sit more than ten minutes. He gives a sign, the servant comes before him and takes him by the hands, and with a practised jerk draws him to his feet, and then assists him in quick shuffling through the room. After this he lets him drop into his chair, and for a few minutes he is quiet.

I ask him the reason of this incessant call to walk, and he says that he has a sensation of being squeezed or pressed to death,—that he must die if he does not move; and during the night he has the sensation of lying on something uncomfortable—he must rise.

No. CXCVI.

Welsted, æt. 26. We have seen a man exercising on a Merlin chair. This poor young man's motions are exactly such, as he sits—an incessant motion up and down, as if there were springs under him. When he stretches his limbs and arms the motion instantly ceases.

He had been treated by a quack for abscess of the rectum,—put upon a course of mercury and caught cold; and it was upon this that his shaking began. At first it began with shaking of the hands, then of the head, and with violent convulsions, which made it necessary to constrain him by strong men; his mind being all the time collected.

No. CXCVII.

——— Complains that he has become gradually weak like a ricketty child; that he cannot balance himself; feels as if a pail of cold water were poured down his thighs. His signature is altered. He has tingling of his hands; numbness of the soles of his feet; does not know when he puts his foot on the step of the carriage; distention of stomach; requires to use the catheter. No pain in the head: never had a fit. These symptoms came on very gradually.

Paraplegia.

Our pathology of this disease is very imperfect, and for want of opportunities of dissection I am unable to add any thing. Since I have been interested in the subject two patients have died; but only common dissections were made, which illustrate nothing. The two last papers of the body of the volume serve to shew how carefully the dissection ought to be prosecuted.

Nor have I learned a great deal from my associates. I attended Mr H. with Dr Maton—Mr S. with Dr Warren—Mr D. with Dr Nevenson—Mr F. with Dr Farre—Mr F. with Sir Henry Halford; besides being in consultation with many gentlemen of extensive practice, without learning any thing further than to alleviate symptoms. The peculiarity which baffles us is the very slow progress of the disease, which renders it almost impossible to observe the effect of remedies. Some of these patients have lived nine and twelve years, with a progressive decay of strength hardly perceptible from year to year.

Remark on the Voluntary Muscles.

In these notes we perceive the connection between the condition of the mind and the voluntary muscles; the state of the latter indicative of weakness of intellect. The idiot stands with knees relaxed, elbows bent, hands hanging, the jaw open, and the tongue filling the mouth, and the speech imperfect. We may observe the slighter indication until the muscles of volition are in complete disorder.

No. CXCVIII.

A child, three years old. Parents in India. The question, Is there defect of mind to be apprehended? He has a smiling, pleasant countenance; but the head is small, the fontenelle closed. He is as familiar with me as with his nurse. Makes no distinction between strangers and those who tend upon him. He has an open mouth and lolling tongue. He cannot speak. There is a continual motion of his hands and fore-arms, twisting them in every possible direction, employing the flexor muscles principally. He has also continual motion of the lower extremities, and can neither walk nor stand. To give a favourable opinion would be to practise deception.

NOTE.

HISTORY OF THIS INQUIRY CONCERNING THE NERVOUS SYSTEM.

N. B.—I am indebted to a Pupil for this Note.

The following was the order of the communications to the public on those investigations of the Nervous System, which were carried on openly in Sir Charles Bell's Theatre of Anatomy, Great Windmill Street, and taught in his lectures.

The "Idea of a New Anatomy of the Brain, submitted for the observations of his friends," was printed in 1811. The following passages will shew how early and how uniformly the author has held the same opinions which are expressed in the body of the present work. There may be some parts which have been rejected as inconsistent with mature reflection, or incapable of proof; yet the principle, that the nerves have different functions, according to the divisions of the brain and spinal marrow from which they take their origin, is distinctly announced; and from it all the rest follows.

"The prevailing doctrine of the anatomical schools is, that the whole brain is a common sensorium; that the extremities of the nerves are organized so that each is fitted to receive a peculiar impression; or that they are distinguished from each other only by delicacy of structure, and by a corresponding delicacy of sensation; that the nerve of the eye, for example, differs from the nerves of touch only in the degree of its sensibility. It is imagined that impressions, thus differing in kind, are carried along the nerves to the sensorium, and presented to the mind; and that the mind, by the same nerves which receive sensation, sends out the mandate of the will to the moving parts of the body.

"It is further imagined that there is a set of nerves, called vital nerves, which are less strictly connected with the sensorium, or which have upon them knots cutting off the course of sensation, and thereby excluding the vital motions from the government of the will.

"This appears sufficiently simple and consistent, until we begin to examine anatomically the structure of the brain and the course of the nerves; then all is confusion: the divisions and subdivisions of the brain, the circuitous course of nerves, their intricate connections, their separation and reunion, are puzzling in the last degree, and are, indeed, considered as things inscrutable. Thus it is, that he who knows the parts the best is most in a maze; and he who knows least of anatomy sees least inconsistency in the commonly received opinion.

"In opposition to these opinions I have to offer reasons for believing that the cerebrum and cerebellum are different in function as in form; that the parts of the cerebrum have different functions, and that the nerves which we trace in the body are not single nerves possessing various powers, but bundles of different nerves, whose filaments are united for the convenience of distribution, but which are distinct in office, as they are in origin from the brain:

"That the external organs of the senses have the matter of the nerves adapted to receive certain impressions, while the corresponding organs of the brain are put in activity by the external excitement; that the idea or perception is according to the part of the brain to which the nerve is attached; and that each organ has a certain limited number of changes to be wrought upon it by the external impression:

"That the nerves of sense, the nerves of motion, and the vital nerves, are distinct through their whole course, though they seem sometimes united in one bundle; and that they depend for their attributes on the organs of the brain to which they are severally attached.

"The view which I have to present will serve to shew why there are divisions and many distinct parts in the brain; why some nerves are simple in their origin and distribution, and others intricate beyond description. It will explain the apparently accidental connexion between the twigs of nerves; it will do away the difficulty of conceiving how sensation and volition should be the operation of the same nerve at the same moment; it will shew how a nerve may lose one property and retain another; and it will give an interest to the labours of the anatomist in tracing the nerves."

The following extract contains the author's opinions of the functions of the spinal marrow, and of the distinct offices of the anterior and posterior roots of the nerves which arise from it. They were introduced by observations, to which he does not now attach importance, on the functions of the cerebrum and cerebellum. Although there is no error in the experiments, or in the conclusions drawn from them, the author has shewn, in his later papers to the Royal Society, that the posterior roots of the spinal marrow, as well as the anterior, come from the cerebrum, but by distinct columns.*

---

* I have to add, that, after making several experiments on the cerebrum and cerebellum, I laid the question of their functions entirely aside, and confined myself to the investigation of the spinal marrow and nerves; a subject which I found more within my power, and which forms the substance of the present volume; and I have placed

"In thinking of this subject, it is natural to expect that we should be able to put the matter to proof by experiment. But how is this to be accomplished, since any experiment direct upon the brain itself must be difficult, if not impossible? I took this view of the subject; the *medulla spinalis* has a central division, and also a distinction into anterior and posterior fasciculi corresponding with the anterior and posterior portions of the brain.

"Further, we can trace down the crura of the *cerebrum* into the anterior fasciculus of the spinal marrow, and the crura of the cerebellum into the posterior fasciculus.* I thought that here I might have an opportunity of touching the *cerebellum*, as it were, through the posterior portion of the spinal marrow, and the cerebrum by the anterior portion; to this end I made experiments, which, though they were not conclusive, en-encouraged me in the view I had taken.

"I found that injury done to the anterior portion of the spinal marrow convulsed the animal more certainly than injury to the posterior portion; but I found it difficult to make the experiment without injuring both portions.

"Next, considering that the spinal nerves have a double root, and being of opinion that the properties of the nerves are derived from their connections with the parts of the brain, I thought that I had an opportunity of putting my opinion to the test of experiment, and of proving at the same time that nerves of different endowments were in the same cord and held together by the same sheath.

"On laying bare the roots of the spinal nerves, I found that I could cut across the posterior fasciculus of nerves which took its origin from the posterior portion of the spinal marrow without convulsing the muscles of the back; but that on touching the anterior fasciculus with the point of the knife, the muscles of the back were immediately convulsed.

"Such were my reasons for concluding that the cerebrum and cerebellum were parts distinct in functions, and that every nerve possessing a double function obtained that by having a double root. I now saw the meaning of the double connection of the nerves with the spinal marrow; and also the cause of that seeming intricacy in the connections of nerves throughout their course, which were not double at their origins.

"The spinal nerves being double, and having their roots in the spinal marrow, of which a portion comes from the cerebrum, and a portion from the cerebellum, they convey the attributes of both grand divisions of the brain to every part, and therefore the distribution of such nerves is simple, one nerve supplying its destined part. But the nerves which come directly from the brain come from parts of the brain which vary in ope-

---

no confidence in experiments made on the brain by modern physiologists, because I had myself seen reason to turn aside from that mode of investigation as unprofitable.—C. B.

[*] It was consistent with the view then taken of the relation of the encephalon. The anatomy is corrected in the two last papers of the present volume.—C. B.

ration; and in order to bestow different qualities on the parts to which the nerves are distributed, two or more nerves must be united in their course, or at their final destination. Hence it is that the first nerve must have branches of the fifth united with it: hence the portio dura of the seventh pervades every where the bones of the cranium, to unite with the extended branches of the fifth: hence the union of the third and fifth in the orbit: hence the ninth and fifth are both sent to the tongue: hence it is, in short, that no part is sufficiently supplied by one single nerve, unless that nerve be a nerve of the spinal marrow, and have a double root, a connection (however remotely) with both the cerebrum and cerebellum.

"Such nerves as are single in their origin from the spinal marrow will be found either to unite in their course with some other nerve, or to be such as are acknowledged to be peculiar in their operation.

"The eighth nerve is from the portion of the medulla oblongata* which belongs to the cerebellum; the ninth nerve comes from the portion which belongs to the cerebrum: the former is a nerve of the class called vital nerves, controlling secretly the operation of the body; the latter is the motor nerve of the tongue, and is an instrument of volition. Now the connections formed by the eighth nerve in its course to the viscera are endless: it seems no where sufficient for the entire purpose of a nerve, for every where it is accompanied by others: and the ninth passes to the tongue, which is already profusely supplied by the fifth.

"Understanding the origin of the nerves in the brain to be the source of their powers, we look upon the connections formed betwixt distant nerves, and upon the combination of nerves in their passage, with some interest; but without this the whole is an unmeaning tissue. Seeing the seeming irregularity in one subject, we say it is accident; but finding that the connections never vary, we say only that it is strange, until we come to understand the necessity of nerves being combined in order to bestow distinct qualities on the parts to which they are sent."

Additional arguments are adduced, in other parts of this essay, to prove the distinct nature of the functions of nerves which have the same appearance, but arise from different parts of the brain. For example, the nerves belonging to the organs of the senses are shewn to possess their peculiar endowments, not from the organization of their extremities, but from the distinct properties belonging to the portions of the brain with which they are connected at their origins. An impression, of whatever kind it may be, on the nerve of hearing, produces a sensation of sound only: an impression on the optic nerve produces a sensation of light only. So the olfactory nerve, and the nerves of taste and of touch, have each their appropriate kinds of sense, and the difference between them is owing to the distinct nature of their origins. This is illustrated by what occurs in the operation of couching for cataract: when the needle pierces the outer surface of the eye, pain is produced; but when it pierces the delicate retina, it is not pain that is felt, but a flash of light is seen. This fact—of the retina being insensible to pain—has been recently presented to the public by M. Magendie as new. It was offered, as one of the proofs, in this early essay, that the nerves are endowed with distinct properties, in correspondence with the difference of their origins; and that the brain cannot, therefore, be regarded as the source of a common nervous influence.

---

* "The medulla oblongata is only the commencement of the spinal marrow."

The opinion of the author—that the different functions of the nerves in the same bundle depended on their roots—is referred to in Dr Cooke's work published in 1821.

"In March 1821 the experiments on the spinal nerves, which are detailed in the 'Idea of a New Anatomy of the Brain,' were performed by Mr John Shaw (Sir Charles Bell's brother-in-law), before the pupils of the Windmill Street School. An account of these is to be found in the 'Medical and Physical Journal' for October 1822. The notes of Mr Cæsar Hawkins, then a pupil, descriptive of these experiments, shew, "that upon irritating the posterior roots of the spinal nerves in three or four places, no effect was produced upon the neighbouring muscles; but when the anterior roots singly, or the whole spinal nerve, was pinched by the forceps, or pricked by the scissors, an evident motion was produced on the muscles, not only perceptible to the eye, but when the third or fourth dorsal nerve was touched, the whole scapula moved in the hands of the assistant. This motion was not communicated to the muscles when the ganglion, which is formed on the posterior root within the sheath, was touched; neither did it follow an injury of the posterior column of the spinal marrow." "The motion given to the muscles was not the slight tremulous motion arrising from the natural irritability still remaining in them, but it was convulsive and spasmodic, and followed each successive prick of the scissors."

In July 1821, the author's first paper on the Arrangement of the Nerves, &c. was read to the Royal Society. The fifth pair was shewn to be the representative of the class of spinal nerves in the head, being a double nerve, viz. a nerve of sensation in virtue of one of its roots, and a motor nerve in virtue of its other—or the nerve of "sensation and mastication." The portio dura, which has only one root, was proved to be a nerve of motion, and incapable of conveying sensation.

In the same month, Mr John Shaw, in his "Manual of Anatomy," explains the author's system, the distinction of the spinal nerves, the similarity of the fifth nerve to them, and the peculiar office of the portio dura of the seventh. The volume is accompanied with the two plans to be found in the present work, one of which shews the fifth, drawn as a spinal nerve; the other shews the irregular nerves.

In December 1821, Mr Shaw wrote a paper on the Facial Nerves in

" Brande's Journal of Science." In this we find it stated, that, at the request of M. Magendie, he had repeated Sir Charles Bell's experiments upon the fifth pair, at *Charenton*, near Paris; and had, at the same time, presented a copy of the " Manual " above mentioned to M. Magendie.

A paper was written by Mr Shaw, in the Quarterly Journal (March 1822), in which he communicated several interesting cases of partial paralysis arising from affections of particular nerves in their course. In this we find a notice of the experiments performed on the ninth nerve.

All the above papers, from July 1821, were translated and introduced by M. Magendie, in his Journal de Physiologie, almost as soon as they appeared in this country.

Mr Shaw's paper on " Partial Paralysis," presented to the Medico-Chirurgical Society, was read in April 1822, and published in June. Besides treating of the paralytic affections of the portio dura, and of the fifth pair, or spinal nerve of the head, it contained an extract (part of that which is given above) from the author's " Idea of a new Anatomy of the Brain," descriptive of the experiments on the roots of the spinal nerves. Reference is also made to those other experiments which were performed by himself before the pupils, a year before, on the same nerves.

It was after all this, in the following July, that M. Magendie published the paper in his Journal that professed to give an original account of these experiments on the spinal nerves.

In presenting his experiments to the public, M. Magendie introduced them as perfectly new, and said that he had not any conception beforehand what would be the result of them. Yet he informs us that he had been for a long time desirous of making them; his only excuse for the delay being, that he could not procure a living animal, fit for his purpose, till a litter of puppies was accidentally brought to him. These details he is careful in giving, although he abstains from mentioning Sir Charles Bell's previous inquiries.

When Mr Shaw, on the other hand, in his paper on " Partial Paralysis," described the experiments that Sir Charles Bell had performed, he treated them as old experiments, instituted more than twelve years before; and he stated that they had been subsequently repeated by himself. Besides, they had been made the groundwork of further important investigations, which had been carried on for many years.

The experiments which M. Magendie related were perfectly isolated; it was not even pretended that their results had been corroborated by other experiments upon analogous nerves. Those performed by the author, and repeated by Mr Shaw, on the contrary, were confirmed by the experiments made upon the fifth nerve of the brain, as well as indirectly by those on the ninth, portio dura, and other single nerves.

M. Magendie's experiments being recently performed, and for the first time, he had no opportunity of illustrating them by occurrences in practice. Here there was another point of difference. The object of Mr

Shaw's paper was, to treat of "Partial Paralysis," and it was in explaining a curious and important species of partial paralysis, that he brought forward the author's experiments on the spinal nerves. The following sentence formed the head title to the division of the paper which treated of this kind of palsy: "Why should Sensation remain entire in a limb, when all Voluntary power over the action of the muscles is gone; or, Why should Muscular power remain when Feeling is gone." The answers given to these questions are the same which would now be given; they are perfectly full and accurate according to our present knowledge of the distinct functions of the roots of the spinal nerves.

Although the original experiments were thus so much more valuable in all their results than those related by M. Magendie, yet it is to be noticed that this gentleman, when he found himself obliged, after a short time, to relinquish his claims to novelty, had the extreme assurance to assert that those which he had performed were the most accurate. He disregarded all the important conclusions, pathological as well as physiological, which had been deduced from the original experiments; presented a short extract from Sir Charles Bell's writings, pretending that it gave a faithful view of his opinions, although it omitted all the most essential points; and closed his paper with saying, " C'est donc à avoir etabli ce fait d'une maniere positive, que je dois borner mes pretensions."

It was, indeed, amusing to find M. Magendie making a boast of superior accuracy, when, in the very same paper, instead of adhering to what he formerly said, he changes his statement respecting the functions of the two roots of the nerves in question, in the most essential manner. In this second communication upon the subject, he gives a totally different account of the results of his experiments, from what he did in his former paper.

The results of M. Magendie's first set of experiments agreed with those described by the author in 1811. Accordingly, when the account of them arrived in this country, and it was found that he claimed the originality of the discovery, means were immediately taken to let the profession know to whom the merit properly belonged. But there was no occasion for this trouble. In his second paper, M. Magendie having abandoned the opinions that he announced in his first paper, and adopted views diametrically opposite to those held by Sir Charles Bell—there was no longer a question of priority between them; the question then was, not who was first, but who was right.

It may justly be said, that if the views of the functions of the roots of the spinal nerves, which M. Magendie presented in his second paper, could have been proved to be correct, they would have destroyed all hopes of improving our knowledge of the nervous system by reasoning upon the anatomy. The fundamental part of the original doctrine was, that the root or nerve which gives sensation is altogether different from that which gives motion; that these endowments are so incongruous in supported by the concurrent testimony of the best anatomists of Europe, that a nerve whose office it is to give motion cannot at the same time bestow sensation; and *vice versa*. When a nerve, like the portio dura or ninth pair, is found, in experimenting upon a living animal, to give rise to pain when pinched or otherwise injured, it is not to be concluded, as some have done in correspondence with M. Magendie's notions, that it is a proof that a nerve of motion can give rise to sensation: it is now agreed that the sensibility which is manifested on such an occasion, is the consequence merely of the nerve being joined in its course by branches of other nerves, which, from being included in the same sheath, convert it into a double nerve, and thus enable it to give sensation as well as motion.

Does it not now strike the reader how small is the amount of credit that is due to M. Magendie for his share in these investigations? When the author had long satisfied himself as to the proper functions of the roots of the spinal nerves, and had advanced to much more difficult subjects of investigation, M. Magendie entered anew upon the inquiries, and contrived to throw every thing into confusion. He raised doubts in the minds of the profession as to the correctness of the very first principles by which the investigations are to be conducted; and time is spent in determining whether or not a single nerve can bestow sensation and motion at the same moment. How was it to be expected that any course of reasoning upon the functions of the more intricate parts of the nervous system could be depended on, when such an important matter as the difference between the nerves of motion and of sensation was left undecided? The only method by which we can hope to gain any knowledge of the distinct uses of the parts situated within the brain, is, by pursuing anatomically the several tracts of nervous matter to which the different nerves are connected, and tracing them inwards; and then, by reasoning upon the distribution and known functions of the nerves, infer what are the endowments of the portions of the brain. How is it possible to place any reliance upon the statements of those experimenters on the substance of the brain in living animals, M. Magendie being himself among the number, who tell us that such a part is the seat of motion in a forward direction,—another of motion in a backward direction,—a third of motion round about (whence they explain vertigo),—a fourth of immobility,—when they do not even pretend to have made out satisfactorily whether or not there is a distinct seat for motion and for sensation! It is truly remarkable the readiness which some of those gentlemen have shewn, to consider things as absolutely proved, concerning which the greatest difficulties must ever exist in coming to any legitimate conclusions, when all the while the simplest and most necessary principles have been allowed to remain undetermined.

It has also been said, that the same discoveries in the nervous system the most delicate and nice observations, although the example had been already shewn him, he would not go beyond the rude experiments upon the spine. If he had taken the nerves of the face, and attempted to confirm his opinions by them, he would have found that they gave no support whatever to his views. When, after a long interval, he turned his attention, at last, to the functions of the fifth pair, it was not with the view of illustrating the distinct uses of the two roots of the spinal nerves; it was not to ascertain whether its ganglionic root gave motion as well as sensation, or its root without the ganglion sensation as well as motion; or whether the portio dura which gives motion has also the power of bestowing sensation. Had he succeeded in establishing these points, he might have had strong grounds for maintaining the opinions which he expressed concerning the corresponding roots of the spinal nerves. But his experiments on the fifth were intended for a very different purpose: his object was to shew that this nerve was endowed with the most singular and inconceivable properties that were ever supposed to belong to a nerve: he attempted to prove that the fifth pair possessed the functions of all the nerves of the five senses; that it was, at one and the same time, the nerve of smelling, of vision, of hearing, of taste, and of touch!

It is not to be imagined that these *improved* opinions of M. Magendie regarding the roots of the spinal nerves or fifth pair, were expressed only out of a spirit of vexation. If this had been the origin of them, he would have abandoned them in his cooler moments. Yet it is a remarkable circumstance, that although the views entertained by this physiologist are so diametrically opposite to those held by Sir Charles Bell, and so irreconcilable with them, their names are commonly found associated together, as if they espoused exactly the same opinions! On English ground especially, they are invariably represented as marching in lock step, both the same way; whereas, the fact is, that as soon as M. Magendie was convinced that he must give up his claims for priority in regard to the experiments on the spinal nerves, he wheeled suddenly round and took a path of his own, to which he has kept ever since. Abroad, particularly in Germany, the difference is better understood; and accordingly, instead of finding their names joined together with the conjunctive *and*, it has been the object of distinct dissertations to determine which of the two is to be considered in the right. The paper by Professor Müller of Berlin, in the *Annales des Sciences Naturelles*, especially deserves to be mentioned, as proving the incorrectness of M. Magendie's opinions. He has taken pains to repeat the experiments on the spinal nerves on a variety of different animals, and with many ingenious contrivances to avoid those sources of error which obviously misled the French physiologist; and the consequence is, that no doubt can now remain that one root is devoted solely to the bestowing of motion, and the other to the bestowing of sensation. Sir Charles Bell's original opinion may thus be considered as established and

EXPLANATION OF THE PLATES.

PLATE I.

VIEW OF THE REGULAR SYSTEM OF NERVES OF THE HUMAN BODY.

AA BB CC Spinal marrow.

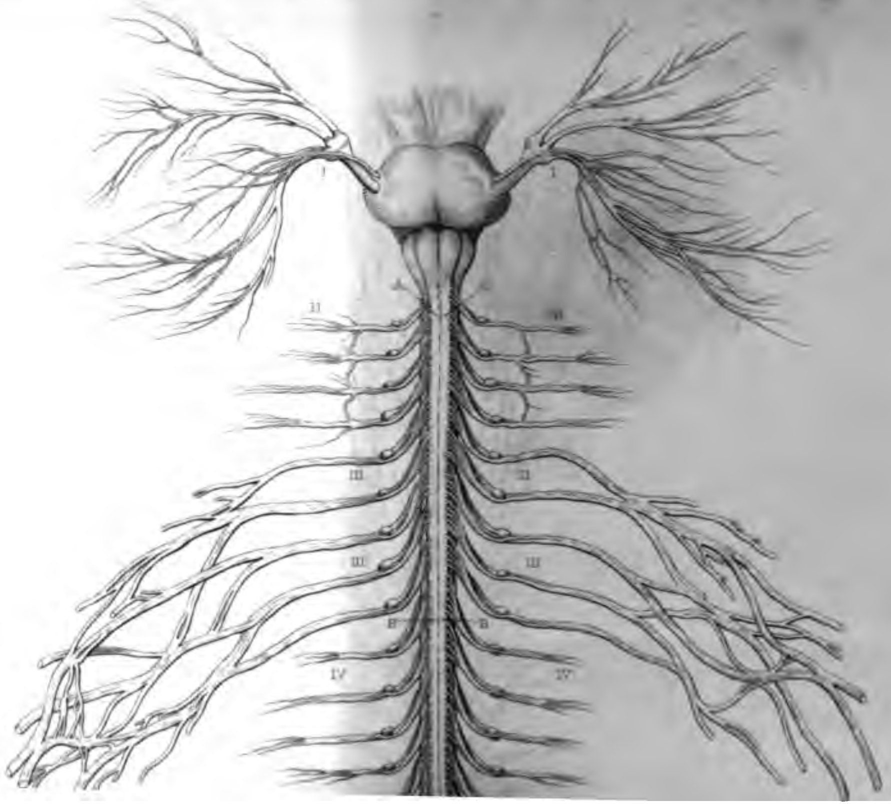
1 1 Branches of the fifth pair, or Trigeminus, which arises in two distinct roots, on the posterior of which a ganglion is seen, like the ganglion of the spinal nerves. The branches of the fifth nerve are universally distributed to the head and face; but the anterior root goes only to the third division.

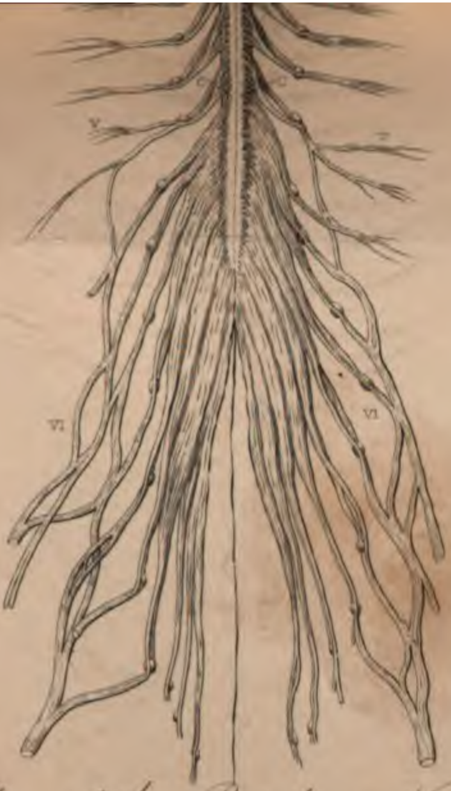
2 2 Branches of the suboccipital nerves, which have double origins and ganglions on the posterior roots.

3 3 The branches of the four inferior cervical nerves and of the first dorsal, forming the axillary plexus : the origins of these nerves are similar to those of the fifth and the suboccipital.

4 4 4 4 Branches of the dorsal nerves, which also arise in the same manner.

5 5 The lumbar nerves.
6 6 The sacral nerves.
} All similar in origin and regular in their distribution.


I
I
A
A
II
II
III
II
III
III
B
B
IV
IV



Plan of the Regular Nerves.

Drawn by C. Bell

Engraved by J. Stewart

PLATE II.

SKETCH OF THE IRREGULAR OR RESPIRATORY NERVES.

A Cavity of the skull.

B Medulla oblongata.

CC Spinal marrow.

D Tongue

E Larynx.

F Bronchi.

H Stomach.

I Diaphragm.

The third, sixth, and ninth nerves are not lettered, but only the following respiratory nerves:—

1 1 1 Par vagum, arising by a single set of roots, and passing to the larynx, the lungs, heart, and stomach.

2 2 Superior laryngeal branch of the par vagum.

3 Recurrent or inferior laryngeal branch of the par vagum.

4 Pulmonic plexus of the par vagum.

5 Cardiac plexus of the par vagum.

6 Gastric plexus or corda ventriculi of the par vagum.

7 Fourth nerve, a nerve of this system to the eye.

8 Respiratory nerve or portio dura to the muscles of the face, arising by a single root.

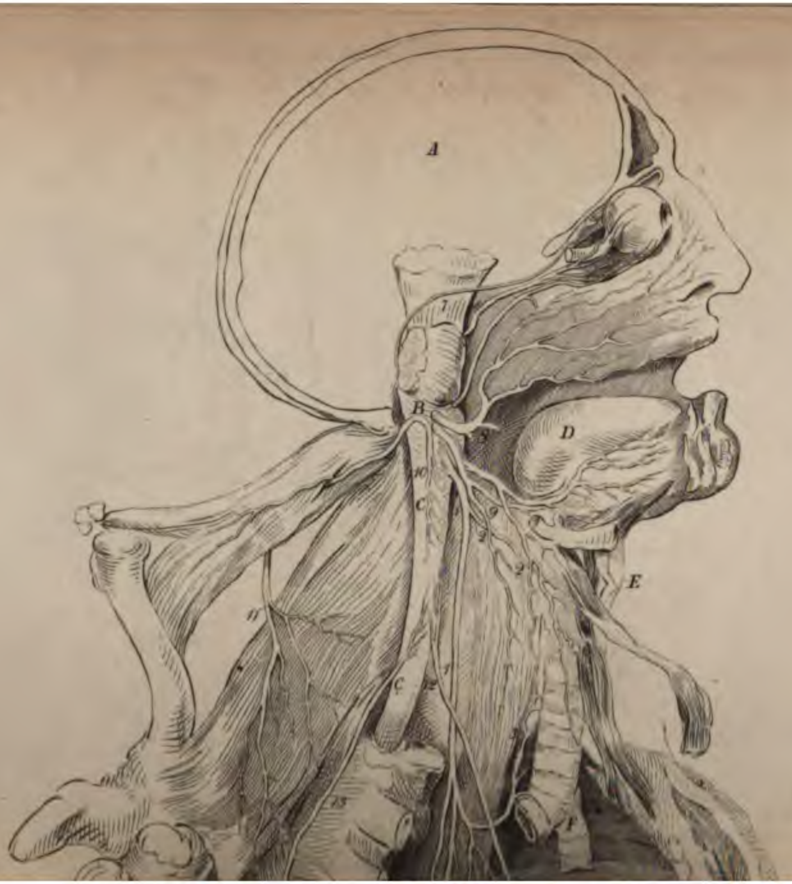
9 Branches of the glosso-pharyngeal.

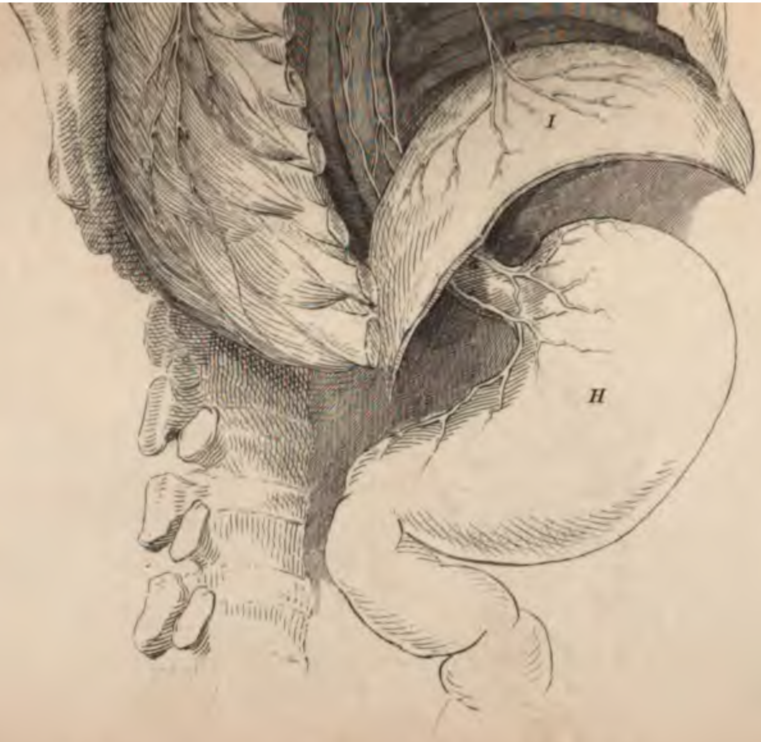
10 Origins of the superior external respiratory or spinal accessory nerve.

11 Branches of the last nerve to the muscles of the shoulder.

12 12 12 Internal respiratory, or the phrenic nerve to the diaphragm.

13 Inferior external respiratory to the serratus magnus.


A
7
B
8
D
10
C
9
9
2
E
11
C
12
7
13
F



Plan of the Irregular Nerves.

PLATE III.

This Plate represents that portion of the spinal marrow from which the nerves of the axillary plexus go off.

A A The medulla spinalis.

B B B B The sheath or theca of the spinal marrow.

C C C C The anterior roots of the spinal nerves, coming down from the anterior or motor column of the spinal marrow, before they join the posterior roots, and before they pass out of the sheath.

D D D D D The posterior roots of the spinal nerves. Between these distinct roots the ligamentum denticulatum intervenes. This is transparent, being a process of the tunica arachnoidea.

E E E E The ganglions formed upon the posterior roots of the spinal nerves. It is seen in this Plate, that, after the ganglion is formed on the posterior root, the two roots coalesce and intermingle to form the nerves.

F F F F F F The axillary plexus formed by the interchange of branches.

G G The lower cervical ganglion of the sympathetic nerve.

H H H H The sympathetic nerve forming its connexion with each of the spinal nerves. Whilst we perceive that the sympathetic system is essentially distinct in character from the other nerves, the fact is here demonstrated that its connections are universal: we see that each twig may be considered as the root or origin of the nerve, with as much propriety as some authors describe the fifth or sixth as giving origin to the sympathetic system of nerves.*

---

* These connexions of the sympathetic with the spinal nerves are formed where the two roots have coalesced, and the fibrils can no longer be distinguished from one another.—See *Scarpa*.

PLATE IV.

This Plate represents the medullary portions which we trace from the base of the brain;—the crura cerebri, the pons varolii, the medulla oblongata, and nerves arising from them.

He who makes himself master of this Plate can have no difficulty in understanding the whole nervous system; he holds the key to it in his hand.

A A The crura cerebri.

B The pons varolii.

C C The corpora pyramidalia, parts of the medulla oblongata.

D D The corpora olivaria, lateral eminences of the medulla oblongata.

E The sheath left on part of the medulla spinalis.

II. The second pair of nerves at their union.

III. The third pair of nerves, arising round the crura cerebri.

IV. The fourth pair of nerves, arising round the crura cerebri.

V. The fifth pair of nerves, arising in two distinct portions from the side of the pons varolii. On the right side (the left of the Plate), the posterior and larger root, the sensitive nerve of the head, is seen to arise distinct; the anterior and lesser root, the motor nerve, arise separately. On the left side (the right of the Plate), the muscular root of the nerve is seen to twist round the sensitive portion and join the right division.

a The muscular portion.

b The Gasserian ganglion, formed on the sensitive portion.

c The ophthalmic and superior maxillary nerves, derived from the sensitive portion of the fifth.

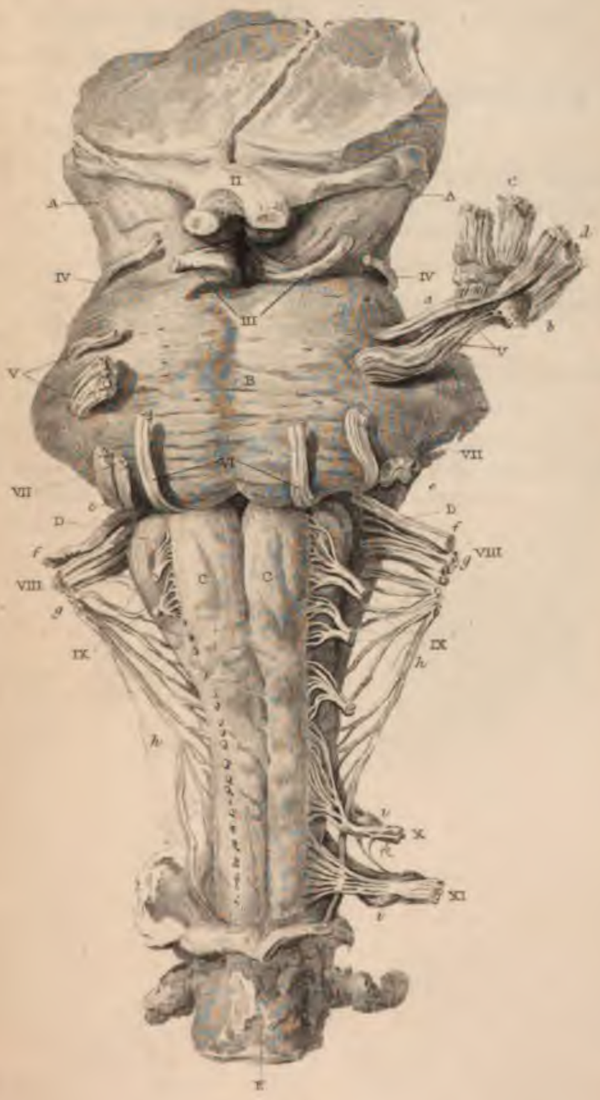
d The inferior maxillary nerve, in which are combined the anterior and posterior portions of the nerve.

VI. The sixth nerve, the abducens.

VII. VII. The portio dura of the seventh nerve, the respiratory nerve of the face.

e e The portio mollis or acoustic nerve.

PLATE IV.



Drawn by C. Bell. Engraved by E. Finden.

VIII. VIII. The eighth pair of nerves, consisting of three respiratory nerves, viz.:—

ff The glosso-pharyngeal nerve.

gg The par vagum.

hh The spinal accessory nerve, or superior respiratory nerve.

IX. IX. The ninth nerve, being the lingual nerve.

X. The tenth nerve of the head, according to the system of Willis; properly the first of the spinal nerves, having, like these, two roots, one anterior for motion, and another posterior for sensibility.

i i The ganglions on the sensitive roots of the nerves.

A twig of communication between the posterior roots of the two superior spinal nerves is not lettered.

XI. A spinal nerve, strictly resembling the fifth nerve in its double roots, and its ganglion on the sensitive root.

If we begin our review of this Plate by tracing up the columns of the spinal marrow, and observing the origins of the nerves in a regular series, we shall have a distinct conception of the system.

PLATE V.

This figure represents a portion of the base of the brain of Mrs F., whose case is related at page 352.

A The left hemisphere of the cerebellum.

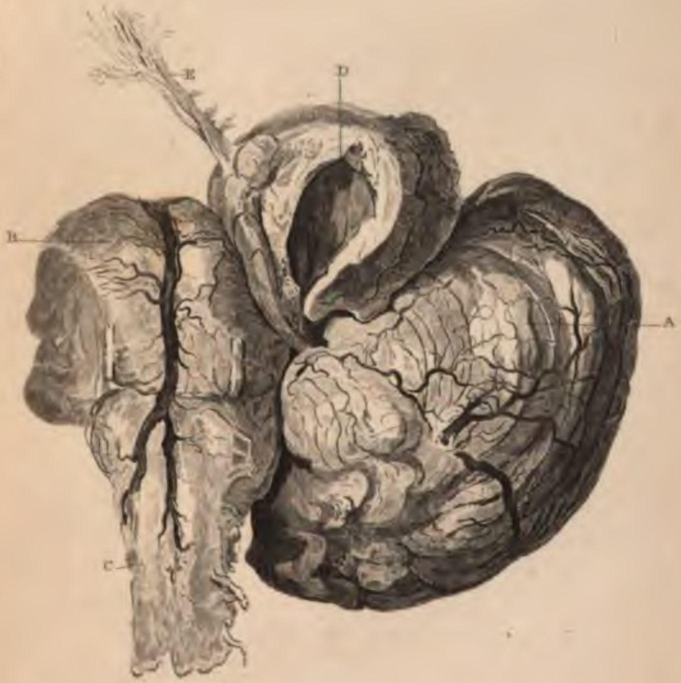
B The pons varolii.

C The medulla oblongata.

D A morbid sac, which pressed upon and destroyed the fifth nerve of the left side.

E The fifth nerve, wasted and almost reduced to cellular texture.

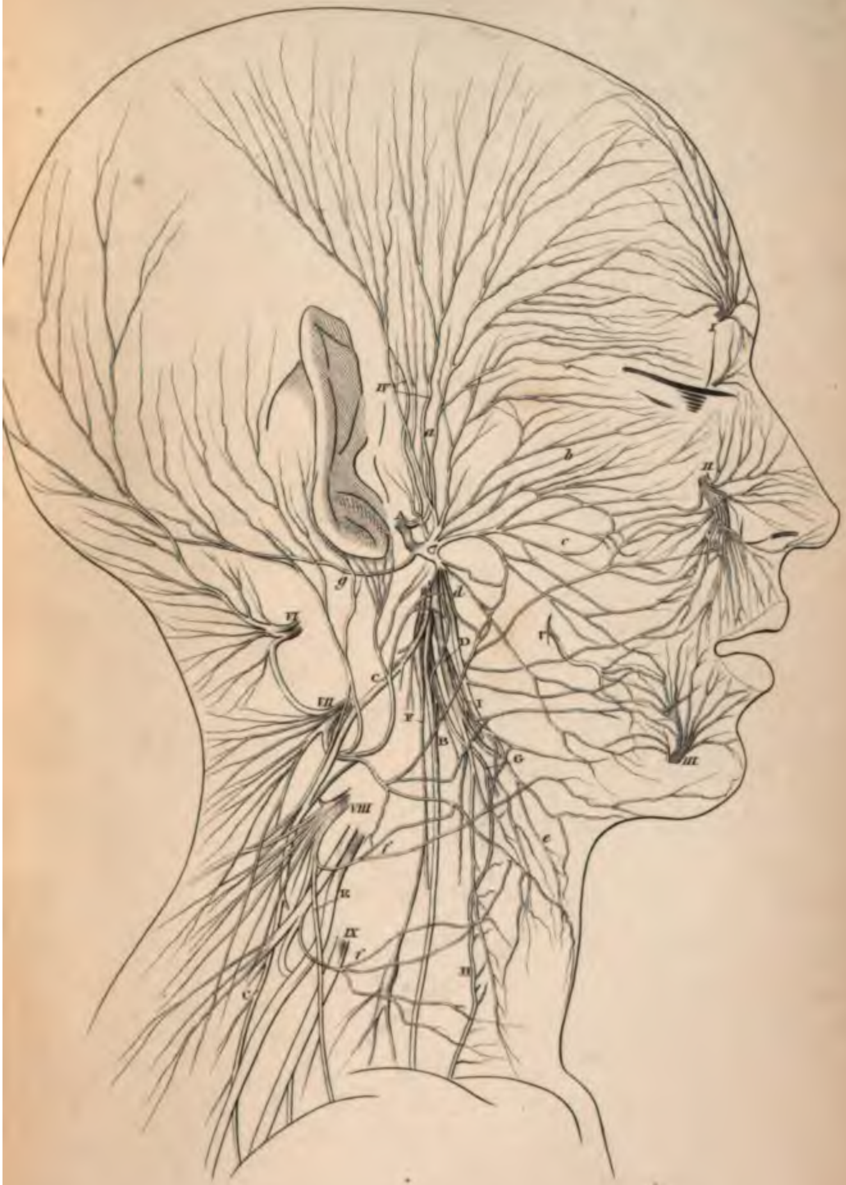
PLATE V.



Drawn by C. Bell

Engraved by E. Finden

PLATE VI.



Drawn by C. Bell

Engraved by J. Stewart

I. Frontal nerve; a branch of the ophthalmic division of the fifth.

II. Superior maxillary nerve; a branch of the second division of the fifth.

III. Mandibulo-labralis; a branch of the third division of the fifth.

IV. Temporal branches of the third divison of the fifth.

V. Ramus buccinalis-labialis; a branch of the third division of the fifth, prolonged from the motor root.

VI. VII. VIII. IX. Spinal nerves.

PLATE VII.

In this Figure the superficial nerves of the face are turned off, and the distribution of the third division of the fifth to the muscles of the jaws and cheek exposed.

A The portio dura of the seventh or respiratory nerve of the face, coming out from the stylomastoid foramen; the principal branches are cut and folded forwards.

B The trunk of the portio dura of the seventh, dissected off the face and pinned out, while it is left at its connections with the branches of the fifth on the cheek and lips.

C The branch of the third division of the fifth nerve, which joins the plexus of the portior dura before the ear. Some experimenters, ignorant of this junction of a sensitive nerve with the muscular nerve, have occupied themselves with experiments to ascertain the degree of sensibility of the portio dura.

D In this figure the masseter muscle is dissected from the jaw-bone, and lifted up to shew D, the branch of the fifth pair of nerves going into the muscle.

E The ramus buccinalis-labialis, that branch of the fifth nerve which goes to the buccinator, triangularis, levator labiorum, and orbicularis muscle.

F That branch of the fifth nerve which, separating from the mandibulo-labralis, goes to the muscles which depress the lower jaw.

G The suborbitary nerve, a branch of the fifth nerve.

H The mandibulo-labralis, a branch of the fifth nerve coming out from the bone to the muscles and integuments of the lip and chin.

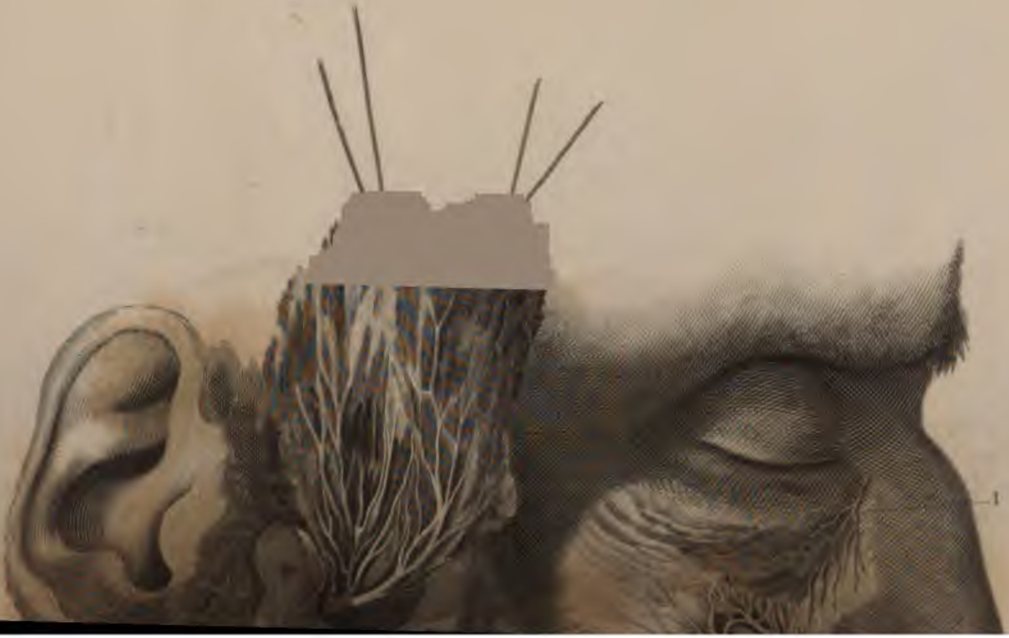
I A branch of the fifth nerve descending from the orbit.

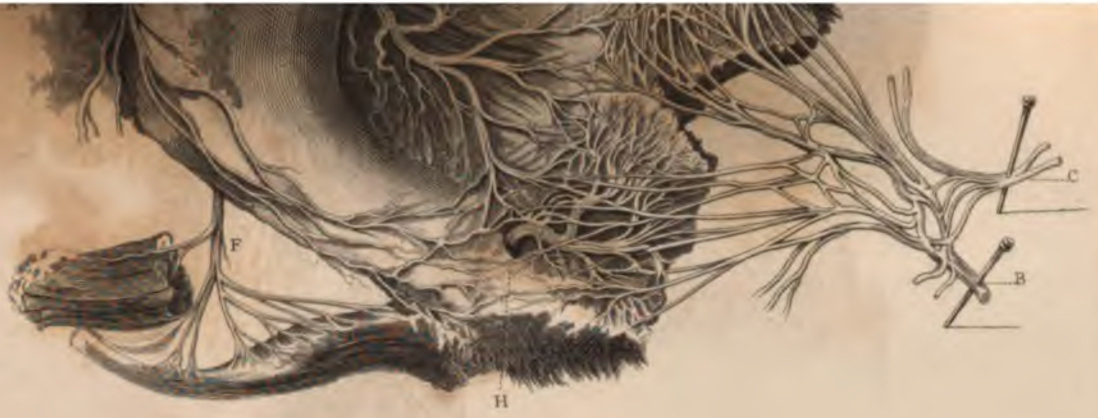
D E F are muscular branches of the fifth nerve, and are motor nerves.

C G H I are sensitive branches of the same nerve which join the branches of the portio dura in its universal distribution; and although these branches of the fifth enter the muscles, they possess no power over their motions.

B is the portio dura, which, though taking the same course with the last, is for a different purpose; while it is a motor nerve it is enabled, by its association with the respiratory nerves, to excite those actions of the face and lips which are necessarily connected with the act of breathing.

Plate VII.





Drawn by C. Bell. Engraved by J. Basire.

PLATE VIII.

Fig. 1. Represents the fifth nerve dissected out, and seen on its lower surface.

A The posterior or sensitive root before it forms the ganglion.

B The gasserian ganglion.

C The anterior or motor root of the nerve passing the ganglion.

D The third or lower maxillary division of the fifth nerve.

E The motor portion joining the lower maxillary nerve, and forming a plexus with it. From this plexus go off the muscular nerves to the muscles of the jaw, viz.—

1. Temporalis.
2. Massetericus.
3. Buccinalis-labialis.
4. Pterygoideus.
5. Mylo-hyoideus.

F Division which joins the portio dura.

G Mandibulo-labralis.

H Gustatory nerve.

I The corda tympani.

Fig. 2. This figure represents the ganglion on one of the spinal nerves, to shew its resemblance to the ganglion of the fifth nerve in every particular.

A The posterior or sensitive root of the nerve.

B The ganglion formed upon the posterior root.

C The anterior or motor root of the nerve; this arises in minute branches which join to form the larger subdivisions, whilst the posterior root is composed of simple and abrupt portions. This division joins the sensitive division beyond the ganglion, exactly in the same manner that the motor portion of the fifth joins the lower maxillary nerve.

Fig. 3. Represents one of the ganglions of the sympathetic nerve, to shew how different it is from those on the symmetrical system of nerves. In Figs. 1. and 2. the nerve, on entering the ganglion and escaping from it, is separated into branches, in a manner very different from the mode in which the sympathetic nerve joins or forms its ganglions.*

---

* Authors who have treated of the anatomy of the ganglions, have not distinguished between the two classes of ganglions as belonging to the sensitive and sympathetic systems of nerves.

PLATE IX.

Fig. 1. Represents the medulla spinalis.

A The pons varolii.

B B The anterior medullary columns of the spinal marrow, continued from the corpora pyramidalia.

C Corpus olivare.

D Corpus restiforme.

1. The origin of the respiratory nerve of the face.
2. Origin of the glosso-pharyngeal nerve.
3. Origin of the par vagum.
4. Origin of the spiral accessory nerve, or superior respiratory nerve of the trunk.

Fig. 2. Plan of the respiratory nerves in their course through the body.

A The sterno-cleido mastoideus muscle.

B B The trapezius muscle. It is seen to arise from the back of the head and from the spine ; it is inserted into

C The scapula, and

D The clavicle.

E E The serratus magnus anticus. It is left at its attachment to the ribs, but cut off from its insertion into the scapula, so as to expose the trapezius and the spinal accessory nerve.

F The lower surface of the diaphragm.

G The upper surface of the diaphragm.

H The larynx.

The four great muscles (A B E E F G) are powerful muscles of inspiration. To simplify this view, the regular or symmetrical system of nerves is not presented in this drawing, but only the respiratory nerves. It is the entwining of nerves of distinct systems, which produces the apparent intricacy. If the spinal nerves were represented crossing these, and the net-work of the sympathetic superadded to them, we should have all the seeming confusion of the dissected body.

Fig. 1.

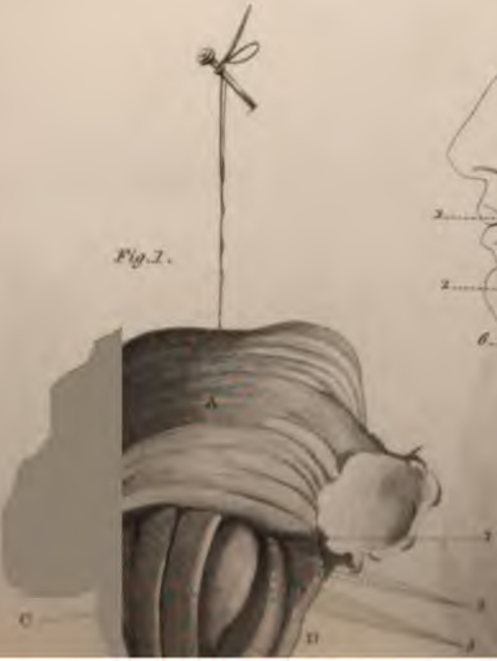
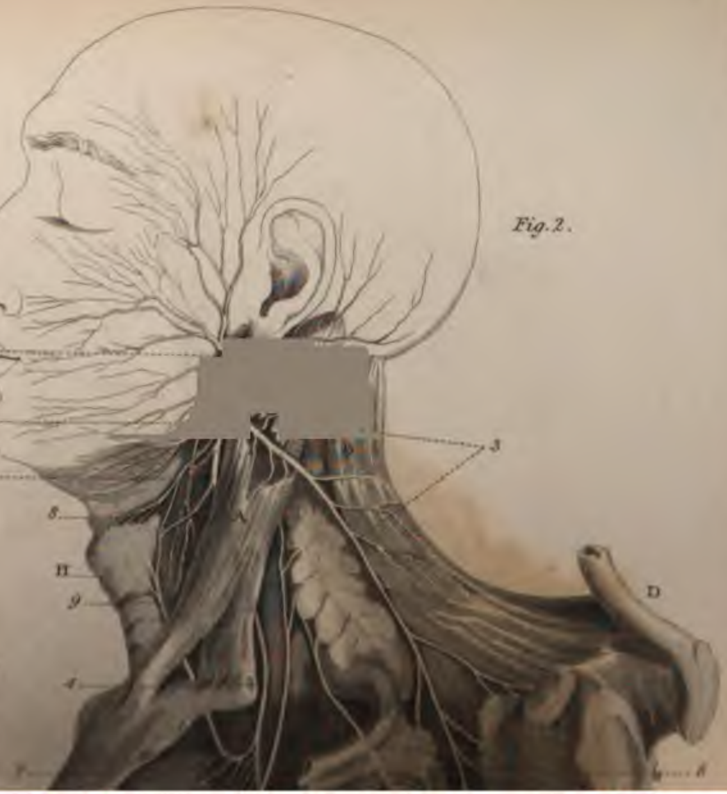


Fig. 2.



B

1. Respiratory nerve of the face, or porta dura of authors.

2. The glosso-pharyngeal nerve.

3. The superior respiratory nerve. It is seen to pass through the sterno-cleido mastoideus muscle, and to supply it with branches; then to take a course down the side of the neck, branching exclusively to the trapezius muscle.

4. The phrenic or diaphragmatic nerve; it is seen coming out from the spine, and running a direct course to the diaphragm.

5. The external respiratory nerve of the chest. It is like the last nerve in its origin, but it deviates in its course, passes on the outside of the chest to supply the powerful respiratory muscle, the serratus magnus E E.

These three nerves, with the par vagum, combine the sterno-cleido mastoideus, the trapezius, the serratus magnus, and the diaphragm, with the lungs, the larynx, the tongue, and nostrils.

6, 7. The nerve of the par vagum. Coming from the same origin with the other respiratory nerves, it passes down to the internal organs; but in its passage gives off these:—

8. The superior laryngeal nerve, a branch of the last nerve.

9. The recurrent nerve, a branch also of the par vagum. Where the par vagum is in the thorax (7), at the same time that it sends off the recurrent (9), it sends off many small nerves to the heart and the lungs, and then descends in a plexus on the œsophagus, to the stomach.

PLATE X.

The figure in this Plate represents the great anterior column which gives off the Nerves of Motion.

A A The fibrous texture of the hemisphere concentrating to form the anterior portion of the crus cerebri.

B The anterior column where it is passing the pons varolii.

C The right pyramidal body; a little farther down is the point of decussation.

D The remaining part of the pons varolii, a portion having been dissected off to expose B.

1. The olfactory nerve in outline.
2. The union of the optic nerves.
3. 3. The third nerve.
4. 4. The fourth nerve.
5. 5. The fifth nerve, Trigeminus.
6. 6. The muscular division of the fifth nerve.
7. The sensitive root of the fifth nerve.
8. The sensitive root rising from the posterior part of the medulla oblongata.
9. The sixth nerve.
10. The portio mollis of the seventh nerve, or auditory nerve.
11. The portio dura of the seventh nerve, or facial nerve.
12. The eighth nerve, viz. par vagum, glosso-pharyngeal nerve, and spinal accessory nerve.
13. The ninth nerve, or lingual nerve.
14. Spinal nerves.
15. Spinal accessory nerve of the right side.

PLATE XI.

Fig. 1. Represents the plates of fibres which pass across the pons and medulla oblongata, and which divide those great columns of medullary matter which we trace down from the cerebrum into the spinal marrow.

A A The posterior septum of the pons, seen from the back part.

B The septum, which, rising perpendicularly from the septum of the pons, divides the great tracts of nervous matter, which descend from the cerebrum, viz. the posterior divisions of the crura cerebri.

C C The lateral septum of the medulla oblongata which separates the corpus olivare from the anterior or muscular tract.

Fig. 2. In this figure the posterior or sensitive tract is shewn. They are separated so as to exhibit the posterior transverse septum of the pons.

A The pons varolii, with the transverse fibres of the septum (Fig. 1. A A).

B B The sensitive tract dissected and separated.

C The union and decussation of the posterior tract.

D D The posterior root of the spinal nerve continued with the posterior tract below the decussation.

E E The sensitive roots and tracts of the fifth pair of nerves.

Plate XI.

Phil. Trans. MDCCCXXXIV. Plate XX. p. 4[illegible]

Fig. 1.

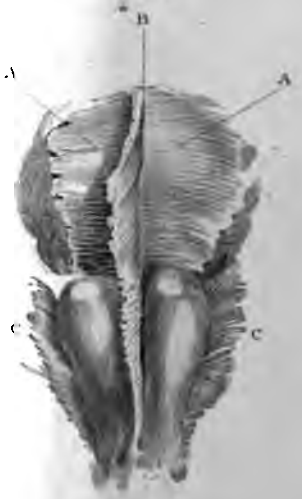
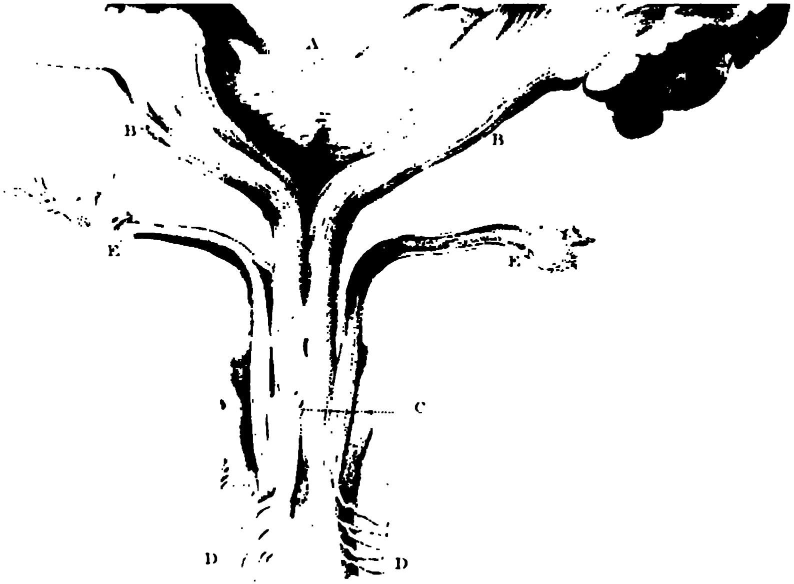


Fig. 2.



Drawn by [illegible]

[illegible]

PLATE XII.

This Figure presents a lateral view (slightly oblique) of the two columns, with a section of the pons and crus cerebri.—The dissections were made of the parts after they had been preserved a long time in proof-spirits.

A Fibrous texture of the anterior tract as it converges from the left hemisphere of the cerebrum.

B A section of the left crus cerebri.

C The motor tract in its course through the pons varolii.

D The corpus pyramidale of the left side.

E E The posterior or sensitive tracts.

F Their union and decussation.

G The corpus olivare, hanging by the tract or column where it is united to the anterior column D, and the posterior column E.

H The superior part of the tract of the corpus olivare running up into the corpora quadrigemina.

I Corpora quadrigemina.

Note.—To complete this subject, refer to Plate XV., which, from an error in the engraving, has been wrong numbered.

ADDITIONAL APPENDIX.

ON

THE ORGANS

OF

THE HUMAN VOICE.

From the Philosophical Transactions.

ON THE ORGANS OF THE HUMAN VOICE.

[*Read February* 2. 1832.]

THE organs of the Human Voice are related to many interesting inquiries in science and philology; and yet it is remarkable that this subject has hitherto occupied no place in the Transactions of the Society. In a matter so open to observation as the anatomy of the throat, there can, indeed, be no new parts discovered; but it will be easy to show that their actions have been very negligently treated.

It will not, I hope, lessen the interest of the inquiry, that I acknowledge having an ulterior object in it. The nerves distributed to the neck and throat are the most intricate of all. That they have not been unravelled, and distinct uses assigned to each, is owing to the complexity and the numerous associations of the organs to which they tend. When we shall have seen the necessity of combination among the various parts, for producing the simplest effort of the voice, we shall find a reason for these numerous nerves, and for their seeming irregularities.

In reviewing the writings of physiologists, we observe defects which are obviously to be ascribed to the great complexity in the organization, and the real difficulty of the subject: but there are others which arise from the habit of resting contented with assigning one use for a part in the animal frame; whereas there is nothing which should more excite our admiration, than the variety of offices destined to be performed by the same organ. It is in contemplating the extent of combination established among the parts of the human body, that we become sensible of its perfection above all comparison with things artificial; and this is especially true with regard to the organs of the voice. They are remarkable for their union or co-operation in function; they all perform more than one office, and are interwoven and associated with parts which serve a double, or even a treble function. But we ought not to be surprised at the intricacy of structure in the human organs of voice, when we find them capable of imitating every sound of bird or beast, excelling all instruments of music in clearness and expression, and capable of making those infinite changes on articulate sounds, which form the languages of the different nations of the earth.

Although there be one subject—Articulate language—on which I shall principally comment, as being that in which the treatises on the voice are altogether defective; yet, as there are lesser points on which I think authors are in fault, I shall take the subjects consecutively or systematically. I do this in the hope of affording, at the same time, a sounder foundation in anatomy, to those members of the Society who are more capable of pursuing this part of philosophy in all its curious and elegant subdivisions.

It will be convenient to divide the inquiry into three heads:—the *Trachea*, the *Larynx*, and the *Pharynx*.

Under the head of *Trachea*, and through the whole investigation, it is necessary to keep the different functions of the part in mind; or we shall be appropriating to the voice, structures which have reference to other functions. We read that the trachea is formed of imperfect hoops of cartilages, joined by membranes, and that it is flat on the back part, for these reasons: that it may be a rigid and free tube for respiring the air—that it may accommodate itself to the motions of the head and neck—and that it may yield, in the act of swallowing, to the distended œsophagus, and permit the morsel to descend. This is perfectly correct; but there is a grand omission. Whilst all admit that a copious secretion is poured into this passage, it is not shown how the mucus is thrown off.

There is a fine and very regular layer of muscular fibres on the back part of the trachea, exterior to the mucous coat, and which runs from the extremities of the cartilages of one side to those of the other.* This transverse muscle is beautifully distinct in the horse. When a portion of the trachea is taken out, and every thing is dissected off but this muscle, the cartilages are preserved in their natural state; but the moment that the muscular fibres are cut across, the cartilages fly open. This muscle, then, is opposed to the elasticity of the cartilages of the trachea. By its action it diminishes the calibre of the tube, and by its relaxation the canal widens without the operation of an opponent muscle.

The whole extent of the air-passages opens or expands during inspiration; and then the trachea is also more free; but in expiration, and especially in forcible expectoration and coughing, the trachea is diminished in width. The effect of this simple expedient is to free the passage of the accumulated secretion; which, without this, would be drawn in and gravitate towards the lungs. When the air is inspired, the trachea is wide, and the mucus is not urged downwards; when the air is expelled, the transverse muscle is in action, the calibre of the tube is diminished, the mucus occupies a larger proportion of the canal, the air is sent forth with a greater impetus than that with which it was inhaled, and the consequence is a gradual tendency of the sputa towards the top of the trachea. In the larynx, the same principle holds; for as the opening of the glottis enlarges in inspiration, and is straitened in expiration, the sensible glottis, by inducing coughing, gets rid of its incumbrance. Without this change of the calibre of the trachea, the secretions could not reach the upper end of the passage, but would fall back upon the lungs.

---

* See Plate XIV. fig. 3. A.

Experiments have been formerly made,* which, although no such view as I now present was in contemplation, prove how the action of the transverse muscle tends to expel foreign bodies. The trachea of a large dog being opened, it was attempted to thrust different substances into it during inspiration; but these were always sent out with impetus, and could not be retained. Why the dog could not be thus suffocated is apparent; the tube is furnished with this most salutary provision to secure the ready expulsion of all bodies accidentally inhaled; the air passes inwards, by the side of the foreign body; but in its passage outwards, the circumstances are changed by the diminished calibre of the canal, and the body, like a pellet filling up a tube, must be expelled by the breath.

Looking on the form and muscular structure of the trachea in man, as providing for expectoration of the secretions poured into the tube, what shall we think of the tracheæ of birds, which are formed by cartilages of complete circles, and which have no compressing muscles? Does it explain the peculiarity, that all the air-tubes of birds are dry; that their lungs are motionless; and that in the air respired by them there is no moisture?

These are the reasons why I must reject the opinion of Portal, that the transverse muscle of the trachea is to give force to the breath in speaking.

The trachea, and all that portion of the windpipe which extends from the larynx to the lungs, may be considered as the porte-vent, or tube which conveys the air from the bellows to the reed of the organ-pipe; and it has even less influence on the quality of sound than the porte-vent. If this portion of the air-tube were to vibrate and give out sounds, it would interfere with, and confuse those which proceed from the glottis. The imperfect circle formed by the cartilages of the trachea and their isolation from each other, are ill suited to convey sound.—But I am now to notice a more particular provision against the propagation of sound downwards by this passage.

If on inspecting a musical instrument we should find a spongy body of the consistence of firm flesh in contact with a cord or tube, and an apparatus by which this body might be pressed against the vibrating part, we should not hesitate to conclude that it damped or limited the vibration. The THYROID GLAND is a vascular, but firm substance, which, like a cushion, lies across the upper part of the trachea.† Four flat muscles, like ribbons, arise from the sternum, first rib, and clavicle, and run up to the thyroid cartilage and os hyoides, over the surface of this glandular body. These muscles are capable of bracing it to the trachea. If it be admitted that the vibration of the trachea would only produce a continued drone, rising over the inflections of the voice, and adding nothing to its distinctness, we may perceive in the adjustment of the thyroid gland to the trachea the most suitable means of suffocating or stopping the vibrations from descending along the sides of the tube.

---

* By M. Favier.

† See Plate XIV. fig. 1. D. D.

Comparative anatomy is often a test of the correctness of our inferences drawn from the human body. I reflected that if I were right in my idea of this being one of the uses of the thyroid gland, there should be no such body, so placed, in birds: and that, following up the inquiry, if we were not likely to discover the function of that gland, we might nevertheless learn why it is so singularly placed. In birds, the sounding apparatus is at the lower part of the trachea; the larynx being, in a manner, divided in its office. At the upper opening there is the structure, and action, and sensibility, constituting it a guard against foreign matter; but the proper organ of sound is formed on the lower extremity of the trachea and in the chest. Hence, in birds, there is this remarkable difference, that the sound must ascend along the trachea. Directed by this consideration, it is not without interest that we notice the absence of the thyroid gland in them; that the trachea itself is a firm tube with cartilages of entire circles; and that there is nothing to suffocate the rising vibrations. In no animal is the thyroid gland of the same relative magnitude as in man.

But it is easy to prove that the trachea has no influence upon the voice. Both in the open pipe or flute, and the pipe stopped at the bottom, as the syrinx, the length determines the note,—lengthening the tube depresses the note, and shortening it makes the sound more acute. A similar effect should result from the elongation and shortening of the trachea, if the changes of the voice depended upon it: but, on the contrary, the trachea is lengthened during the high note, while it is shortened as the voice descends, and the notes become graver.* I have no ear to determine what harmonic sounds attend the human voice; but supposing that sounds proceed from the trachea, which is shortening, at the same time that they proceed from the upper part of the tube, which is lengthening, it is clear to demonstration that the two portions of the tube can never consent or keep any proportion in their vibrations.

For these reasons I apprehend that, in the structure and condition of the trachea, the design manifestly is to suffocate the vibrations of sound, and so to impede the motions originating in the larynx from being propagated downwards.

Pursuing our inquiry into the organs of the voice independently of articulation, and looking more particularly to the *Larynx,* we shall find that the common opinion is confirmed by experiment and every analogy.

---

* Fabricius ab Aquapendente, seeing the contraction and elongation of the trachea during the changes of the voice, presumed that these motions must be the cause of them. Dodart showed the incorrectness of this.

that the glottis is the primary seat of sound—the source of the vibrations communicated to the air as it is breathed. But to consider the motions of the glottis, and even the modulations of the air in the larynx, as the sole source of sound, would be incorrect. Ferrein described the edge of the glottis as being like the strings of the violin, and the air brushing over it like the bow. But even in that supposition, though the vibration of the string of the violin is necessary to the production of sound, yet that sound receives modification through the form and condition of the instrument. As the same chord, vibrating in the same time, will produce a sound the quality of which varies in different instruments, so will the sound of the chordæ vocales be influenced in the pharynx. As a tuning-fork, or a moveable musical instrument, will have the quality and power of the tone changed by its position and the material with which it is in contact, so will the vibrations of the human glottis be affected by the parts above and against which the sound is directed.

The breath, which plays inaudibly in respiration, becomes vocalized when the ligaments of the glottis, or chordæ vocales, are braced so as to cause the edges of the glottis to vibrate in the stream of air. In a wind instrument the air must be impelled with a force to make the sides of the tube vibrate; so, in the production of sound from the human organs, there must be a certain pressure of the column of air. But in the organs of the voice there is this superiority, that there are not only the means of regulating the pressure of the column of air, but of adjusting the vocal chords, so as to suit them to the most delicate issue of the breath. The metal tongue in the organ-pipe is, by lengthening or shortening it, accommodated so as to vibrate in time with the air contained in the tube. So is the edge of the glottis regulated; but with an apparatus for adjustment the most perfect.

Besides the adjustment of the vocal chords, there is a very superior provision in the motions of the chest which supply the air, to that of any musical instrument. Although the organ has allotted to each note a separate pipe, whose relative dimensions are proportioned with mathematical precision, yet the air propelled through the pipes can never be so regulated as it is by the combination which exists betwixt the motions of the chest and the glottis. The church organ could not be made to approach the precision of adjustment in the human organs, were there as many pairs of bellows as there are pipes, and each adjusted by a weight or spring, to accommodate the pressure of air to the dimensions of the pipes.*

Referring to the Plates for the anatomy,† I may continue my comment on the form and uses of the parts. The thyro-arytenoid ligaments, or chordæ vocales of Ferrein, are the lower ligaments of the glottis; they form the chink of the true glottis. These ligaments do not stand distinct from the sides of the tube, but the fine lining membrane is reflected over them. This membrane, sinking between the inferior and superior ligaments, forms there the sacculus or ventriculus laryngis. Another reflexion passes from the extreme point of the appendix of the arytenoid cartilage to the base of the epiglottis. These inflexions of the membrane of the glottis produce a considerable intricacy in the passage of the larynx. Nevertheless, when this piece of anatomy is fully displayed the number of muscles inserted into the arytenoid cartilages, and the effect of their motions on the lower ligaments, point to these as the chief parts, and to the others as subordinate, in producing sound.

---

* Which is attempted in some automata.

† See Plate XIII.; and Plate XIV, fig. 2.

There are, however, circumstances which lead to the belief that the sacculus or lateral cavity of the larynx has much influence on sound. We perceive that one effect of this cavity is to hold off the inferior ligament from the side of the tube, and to give freedom to its vibrations. But the varieties in its size and form, exhibited by comparative anatomy, and the influence which some of the muscles of the arytenoid cartilages* must have upon it, point it out as an essential part of the organ of sound; and the ear-piercing cries which belong to such animals as the Beelzebub ape, in which this cell is large, confirm the notion.

The seat of the vibrations which produce the voice is so fairly indicated by the whole anatomy, and confirmed by observation, that there is hardly an excuse for those experiments which have exhibited the motions of the chink of the glottis in living animals.† It is, on the whole, better to wait our opportunity of inspecting these parts in action in man. In consequence of wounds of the throat, I have had repeated occasions to witness the motions of the glottis in man, both during simple breathing and in speaking. On every inspiration the glottis dilated. Upon asking the patient to speak, and encouraging him, when no sound proceeded, by saying that I could understand him by the motion of his lips, I have seen that in the attempt at utterance, the glottis moved as well as the lips. Although these occasions be too painful to admit of protracted experiment, I could not omit to observe that there is a motion of the glottis in correspondence with the efforts of the other organs of voice.

We have already understood the necessity of the tongue of the organ-pipe being adjusted in its length, both to the force of the wind from the bellows, and that it may vibrate in correspondence with the column of air in the tube. Granting that the analogy between this instrument and the organ of the voice is just, we must acknowledge the very superior means possessed by the living parts, of drawing out the margin of the glottis, to that by which the tongue of the organ-pipe is adjusted.

---

* Thyro-arytenoideus and Crico-arytenoideus.

† The larynx of a dog being partially dissected, so as to expose the glottis, the experimenter tortured the animal to observe how the acuteness of the note, and the constriction of the chink of the glottis, bore relation to the severity of pain. After ascertaining the degree of contraction from the pinch of the tail to the application of the red-hot iron, he set himself with a tuning-pipe to sound in harmony.—*Archives Générales de Medecine*, tom. xxv. Mars, 1831.

If we should adopt the fancy to compare the membrane which is stretched over the ligament to a drum, then the arytenoid muscles would be the braces to tighten the membrane, and the ligaments would be as the snares on the reverse of the drum. But all such comparisons serve to shew that, taking this portion only of the apparatus for the voice, it surpasses every instrument in the property of accommodation—of sounding in unison with the rest of the tube, and with the column of air.

Of the Pharynx, and of the Formation of Articulate Sounds.

We come now to a division of our subject which, notwithstanding its higher interest, has been imperfectly treated by authors, and where the actions essential to articulate language have been altogether omitted.

Tracing the volume of simple sound in its ascent from the glottis, we see how well the epiglottis is calculated to direct it on the passages above.* Immediately over the epiglottis hangs the velum palati; this curtain is formed by certain muscular fibres, which draw down the mucous membrane from the back part of the bony palate into a great fold; whilst other muscles, their oponents, furl it up. This velum forms a partition which divides the mouth from the posterior cavity, arrière bouche, or pharynx; and the velum, the uvula, and the arches of the palate vary their condition during the production of simple sounds.

When the parts are displayed, so that we may look on the outside and posterior aspect of the great bag of the pharynx, we see how well it is adapted for the office which I shall assign to it in the formation of the human voice. It presents to our view a flat expanded web, of a fleshy or muscular texture, and it extends from the base of the skull to the extremities of the horns of the os hyoides and those of the thyroid cartilage, between which it is stretched and held out. Behind, its connexions are loose; and as it forms a principal boundary of the bag of the pharynx, the great cavity of that bag is directly in front of it. If we trace the pharynx upwards from the closed extremity of the œsophagus, we perceive the glottis opening into it below; whilst above, it is terminated by the posterior nostrils, and anteriorly by the mouth.

Considering the passage for the voice as one irregular cavity, extending from the glottis to the lips and nostrils, we shall find it subject to great changes, and powerful in its influence on the voice. For although the breath is vocalized by the larynx, both the musical notes in singing and the vowels in speech, are affected by the form and dimensions of this cavity.

Notwithstanding the ingenuity displayed in experiments on animals, to shew that their cries proceed from the larynx, we have no authority to disregard the fact, that when a person who has divided the pharynx, and exposed the top of the windpipe, attempts to speak, no sound issues from the larynx. By great effort he may produce a noise ; but anything like the common effort of speaking is attended with no audible sounds. From this we must infer that the delicate vibrations, necessary to articulate language, are influenced not merely by the action in the glottis, but by the condition of the walls of the pharynx ; the cavity into which the sound is thrown.

---

* See Plate XIII.

In this part of the air-passage we shall find an exact correspondence with the flute or pipe, in as far as it is lengthened during the grave sounds, and shortened in the acute. Even if it were proved that the note is made to rise and fall by the contractions of the glottis, the great apparatus employed to move the pharynx cannot be useless. We are countenanced in concluding, that, as the tube of the organ is adjusted to the reed, so is the condition of the pharynx made to correspond with these contractions of the glottis. It is impossible to see a singer running up the notes to the highest, without admitting that there must be a powerful influence produced through the alternate shortening and elongation of the pharynx and mouth. To allow the cavity to be shortened in the greatest degree, the larynx is raised, and the lips retracted ; on the contrary, the trachea descends, and the lips are protruded, to lengthen the cavities, and to give out the lower or graver notes.

Of Articulation.

In pronouncing the simple continued sounds, the vowels, and the diphthongs, which are the combinations of open sounds, the pharynx, at all times irregular, varies its form or dimensions, without interrupting or cutting the sounds. These sounds are universal and expressive. What we have now to consider are more conventional, and form the constituents of articulate language.

It has been imagined that the vocalized breath ascending to the mouth is there divided, and articulated by the tongue, teeth, and lips ; and that this comprehends the whole act of speech. Such a description implies a very imperfect acquaintance with the actions which produce articulate language.

It is now my purpose to shew, that in articulating, or forming the consonants, the pharynx is a very principal agent ; and that this smaller cavity is substituted for the larger cavity of the chest, to the great relief of the speaker, and the incalculable saving of muscular exertion.

The late Dr Young made a comparison of the power employed by a glass-blower, in propelling the air through his tube by the force of his cheeks, and in propelling it by the force of his lungs ; and calculating the ease with which the lesser cavity is compressed in comparison with the greater,—that is, the cavity of the mouth compressed by the muscles of the cheeks, compared with the whole extent of the chest compressed by the muscles of respiration,—he concluded, that the weight of four pounds would produce an operation through the lesser cavity, equal to seventy pounds weighing on the larger cavity.

The quality of fluids, by which they transmit pressure equally in all directions, is the cause of this and of some other results which appear paradoxical. It is a property too nearly allied to mechanical power, and too important to be left out of the scheme of animal structure.

When a forcing-pump is let into a reservoir, it produces surprising effects. The piston of the hydraulic press being loaded with a weight of one pound, the same degree of pressure will be transmitted to every part of the surface of the reservoir, equal in magnitude to the base of the piston. And, on the contrary, supposing the power to be employed on the reservoir for the purpose of raising the piston, it would require the weight of a pound on every portion of the superficies of the reservoir, equal in extent to the base of the piston, to raise the piston with a force of one pound.

We cannot fail to notice the effect of this law on the cavities of the animal body, in diminishing the power of muscular bags in proportion to their increased capacity.

Elastic fluids are subject to a similar influence, from the pressure extending in every direction, and the resistance always being equal to the pressure. A man standing on the hydraulic bellows, raises himself by blowing into the tube: and, contrariwise, the weight of his body does not produce from that tube a blast of air superior to the force of contraction of his cheeks. A very slight pressure against the nozzle of the common bellows will resist the compression by the handles; and by blowing into the nozzle, we may raise a great weight placed on the boards. To reconcile us to the influence of this principle, as applicable to the animal economy, we shall take an example before applying it to our present subject.

A sailor leaning his breast over a yard-arm, and exerting every muscle on the rigging, gives a direction to the whole muscular system, and applies the muscles of respiration to the motions of the trunk and arms, through the influence of a small muscle that is not capable of raising a thousandth part of the weight of his body. He raises himself by the powerful combination of the muscles of the abdomen, chest and arms; but these muscles are controlled and directed by the action of a muscle which does not weigh five grains. The explanation is this;—a man preparing for exertion, draws his breath and expands his chest. But how is this dilatation to be maintained? If the muscles which expand the chest are to continue in exertion to preserve it so, there must be a great expenditure of vital force; besides, these muscles are now wanted for another office. The small muscle that closes the chink of the glottis suffices. It contracts on the extremity of the windpipe; and here, acting so as to confine the column of air, it is superior to the united power of all the muscles of the chest and trunk of the body which act upon the cavity of the thorax. However powerful the muscles of expiration may be in compressing the chest, their influence is very small on the column of air in the windpipe; the pressure there being no more than on any part of the walls of the chest, which is of the same diameter as the base of the tube. The closing of the glottis by this small muscle, throws all those of the chest and abdomen, which are otherwise muscles of respiration, free to act as muscles of the trunk and arms.

But if any defect of the windpipe, or of the muscle which closes it, permit the air to escape, the muscles of the chest and abdomen sink with the falling of the chest; they become muscles of expiration, and lose their power as muscles of volition, consequently all powerful efforts cease in the instant. When an unhappy suicide thinks to perpetrate self-destruction by dividing his windpipe, his sensations of sudden and total failure of strength announce the accomplishment of the act: but he is deceived. In the moment of lunatic excitement, his energies are wound up, and his breath is drawn and confined; but now the trachea being divided, in the instant he is seized with feebleness; for the compressed air is let loose, the chest subsides, and the whole muscles of the trunk and arms are lost to the actions of volition. He feels as if struck with the sudden influence of death; his actual death depends on other circumstances.

Thus we perceive that the muscle of the glottis, not weighing a thousandth part of the muscles of the trunk of the body, controls them all; changing them from muscles of respiration to muscles of volition; and this it is enabled to do on the principle of the hydraulic press.

We are by these instances prepared to understand the great importance in the animal economy, of power being employed on the lesser cavity in preference to the larger;* and how much will be saved if the appulse necessary in articulation be given by the pharynx instead of by the greater cavity of the thorax.

In a person whom I had the pain of attending for a long time after the bones of the upper part of the face were lost, and in whom I could look down behind the palate, I saw the operation of the velum palati. During speech it was in continual motion; and when this person pronounced the explosive letters, the velum rose convex, so as to interrupt the ascent of the breath in that direction; and as the lips parted, or the tongue separated from the teeth or palate, the velum recoiled forcibly.

These facts lead us to the further contemplation of the pharynx. We see it to be a large cavity behind the palate, formed by a dilatable bag, and acted on by many muscles. We have seen that the volume of sound issues into it from the glottis below; and that although it opens into the nose above, yet this passage is closed, whenever the velum is raised, like a valve, in the manner just described; at such a time, if the mouth be also shut, the bag will be closed on all sides, and may then suffer distention by the vocalized breath ascending through the glottis.

---

* The principle is as important in its application to pathology as to the natural functions. It explains the weak pulse which attends the dilated heart; how the contractions of the uterus become more powerful in the progress of labour; and why the distended bladder acts with diminished power in the expulsion of the urine through the urethra. On the same grounds we understand how a slight spasm in the canal of the urethra will resist the most powerful contractions of an enlarged and thickened bladder, aided by the pressure of the abdominal muscles.

In speaking, much of the sound, as of the vowels and diphthongs, is the uninterrupted issue of the vocalized breath, modulated by the passages, and differently directed, but not checked or interrupted. The consonants are the same sounds checked by the tongue, lips, or teeth. At the moment of this interruption, the pharynx, being distended, is prepared to give an appulse by its muscular action exactly in time with the parting lips.

If we grasp the throat whilst speaking, so that the fingers embrace the bag of the pharynx, we shall feel that each articulate sound is attended with an action of the pharynx; and preceding each explosive letter, we shall be sensible of a distention of the throat. By a close attention to the act of breathing, we shall perceive that, whilst the distended chest falls gradually and uniformly, the bag of the pharynx is alternately distended and compressed in correspondence with the articulated sounds.

We can now conceive that if each appulse of the breath in speaking arose from the action of the chest, it would be attended with great and unnecessary exertion; since in proportion to the size of the reservoir and the smallness of the tube that gives issue, would be the force required on the sides of the reservoir to produce an impulse along the tube. If each consonant and accented syllable required the action of the whole thorax, we should find that a man, instead of being able to deliver an oration of some hours in length, would be exhausted in a few sentences; like a person who bellows and gives pain by the violence and consequent ungracefulness of his action.

If we enter into a more particular examination of the formation of the consonants, we shall perceive that, without the action of the pharynx, those letters must have been mutes which, through its operation, do in fact give the greatest force and distinctness to language. The circumstances which I have to notice could not altogether escape the observation of grammarians. They speak of the guttural sounds as belonging to the production of certain consonants. Bishop Wilkins expresses this by referring to that *murmur* in the throat before the breath is emitted in pronouncing these letters. Thus grammarians distinguish the mute letter P, which has no sound previous to the parting of the lips, from B, which has a guttural sound before the explosion of the lips.

Had the cause of this sound been investigated, these ingenious men would have presented the subject to us in greater simplicity. "This guttural sound," they say, "is produced by a compression of the larynx or windpipe:" but this has no meaning, and cannot pass for an explanation. This murmur, like all other sounds, proceeds from the vibration of the glottis; but, as we have seen, the glottis cannot vibrate without the ascent of the breath through it;—how, then, is this murmur to be produced when the mouth is closed, and there is no aspiration? The air ascends because the bag of the pharynx, or arrière-bouche, is filling. It is during the distention of the bag that the breath ascends and produces the sound which precedes and gives the character to some of the explosive letters; and it is this preceding murmur which distinguishes these letters from others, produced by the same position of the "organs" in the mouth, but which are mute or nasal. Thus the triad of consonants D, B, G (hard), are called semimutes, because, without the assistance of any vowel, they are attended with a faint sound, "which continues for a little time." The letters T, P, K are produced by the same position of the organs of the mouth, but they are preceded by no murmur; and therefore it is that they are called mutes: whereas, in D, B, G, the pharynx fills, preceding the parting of the lips. It is this filling of the pharynx, and consequent murmur in the glottis, which gives reason for the grammarians to say that these letters, D, B, G, are accompanied with a sound, though not joined to a vowel, and to call them semimutes.

Grammarians admit "that the mouth is not the proper organ for producing sound, but only the organ for modulating and articulating the specific sounds;" and having explained the formation of the vowels, they proceed to the formation of the consonants, accounting for their peculiar sounds by the position of the lips, tongue, and palate.

We perceive that their explanation must necessarily be imperfect, owing to their ignorance of the anatomy, and especially of the action, of the pharynx. For example, P, B, and M, they say, are consonants formed by the application of the lips to each other: but this leaves the peculiar character of each letter unexplained, since all three are formed by the lips. The real difference is this: P gives no sound previous to the parting of the lips; it is the vowel abruptly sounded by their separation. B differs only inasmuch as the sound precedes the opening of the lips in the manner I have just explained; and as the pharynx, after being distended, contracts and forces open the lips, this letter is very properly called explosive. M, too, is in part owing to the articulation through the lips; the sound, commencing in the vowel, is interrupted by the shutting of the lips; after which it continues in a murmur; with this difference from the guttural murmur—that it ascends into the cavities of the face, the velum being lifted. The same difference is shewn in other letters, as F and V. If we attempt to articulate certain letters in a whisper, we shall find how much the distinctness depends on the swelling of the pharynx. In a whisper it is with much difficulty that we can distinguish P from B, or T from D, or G (hard) from K.

Thus we see that the consonants, classed according to their formation in the mouth, have varieties consequent on the action of the pharynx.

1st, The consonants formed by the closed lips: 2nd, Those formed by the meeting of the lips and teeth; 3rd, Those formed by the tip of the tongue and palate; 4th, Those formed by the dorsum of the tongue and palate. All of these admit of variety by the operation of the pharynx and velum; viz. they are mutes, explosive semimutes, and nasal liquids. For example, taking the position of the tip of the tongue against the teeth as forming a consonant, we have T, the mute; D, the semimute, in which the sound precedes the explosion; and N, the sound which rings through the nasal cavities after the closing of the passage through the mouth.

From the same misconception of the actions which combine to form the voice, it may be, that grammarians do not give us a very clear account of emphasis and accent. We perceive that there are two sources of the force with which the words are uttered,—the chest, and the pharynx. The emphatic delivery of several words or syllables must proceed from the forcible expulsion of the breath by the effort of expiration; but the emphasis on the single syllable, and the forcible enunciation of the letter on which the clearness and distinctness, and sometimes the meaning, of words depend, must be produced by the effort of the pharynx.

Proofs of the Correctness of the Opinions advanced, drawn from the effects of accident and of disease occurring under the Author's observation.

1. A child having drawn the broken shell of an almond into its windpipe, was in momentary danger of suffocation; and could utter no sound until the shell was extracted by incision.*

2. Owing to disease of the glottis, it was necessary to open the membrane between the thyroid and cricoid cartilages; the voice instantly ceased; and no sound could be produced, while the air passed freely from the wound: "the harsh sawing sound of the air in the contracted glottis immediately ceased, and the air played easily with a stiffling sound through the wound."

3. A small pebble having fallen into the glottis of a child, there was a stridulous sound in drawing the breath, but no voice in the expulsion of the breath.

4. When an ulcer had destroyed the margins of the glottis, and the sacculi, the patient spoke in a husky whisper, "reedy and very feebly."

5. Thickening of the membrane of the glottis and epiglottis had a similar effect, the person speaking painfully in a whisper.

---

* The probe was passed several times into the windpipe, and past the broken shell without discovering it. It had been caught by the action of the transverse muscle, and the sharp broken edge forced into the mucous membrance; which was the reason that it was not coughed out of the wound.

6. A man died of suffocation from a pustule, which formed on the margin of the false glottis; whilst he breathed, the sound was like the noise of a saw, harsh and loud.

7. The epiglottis being destroyed, and a deep ulcer in the sacculus, "the man attempted to call, but with a husky sound."

8. When the interior of the larynx was coated with coagulable lymph, except the clangour, during coughing, the voice was quite gone.

9. When the suicide has divided the larynx from the tongue, and opened the pharynx, no sound issues from the larynx in his attempt to speak; and it requires a powerful effort to produce any sound at all. When the glottis is thus exposed, it is seen to move in the effort to speak.

10. The loss of the velum pendulum palati was attended with the defect of articulation; the sounds were run together and nasal.

11. When polypus fills the cavities of the face, the voice is deficient in sonorousness and clearness.

12. When a communication is formed between the mouth and nose, the sound is nasal, and the articulation imperfect.

13. The entire removal of the bones of the face deprived the voice of all force, and gave it a sound which we should have called nasal, had any part belonging to the nose remained.

14. The defect of nervous influence in depriving the muscles of the velum and pharynx of due tension (as in apoplexy), produces stertor or snoring. That this depends in a great measure on the relaxation of the velum, appears from this,—that changing the position of the head, so that the velum shall not hang against the back part of the pharynx, removes the distressing sound.

15. In extreme weakness, as from wounds and loss of blood even to insensibility, groaning proceeds from the condition of the glottis; as if the call for sympathy and assistance were intended to be the last effort of life.

By these facts it appears; 1*st*, That the trachea gives out no sound of itself; 2*d*, That when the passage of the trachea is much encroached upon, the column of air is not sufficient to move the cords of the glottis; 3*d*, That whatever interferes directly with the motion of the glottis, reduces the voice to a whisper; 4*th*, That when the larynx is separated from the pharynx, delicate sounds are not produced, and therefore an influence of the pharynx upon the stream of air is necessary to the production of such sounds; 5*th*, That any permanent opening or defect of the velum, which shall prevent the distention of the pharynx and the closing of the passage to the nose, renders articulation defective; 6*th*, That the removal of the cells of the face, equally with their obstruction, deprives the voice of its body and clearness; 7*th*, In nervous relaxation of the muscles of the throat, there is sound; but its nature evinces how much the proper action of the muscles is necessary to the voice.

Recapitulation.

It is curious, and not without its use, to observe how many parts must conform, and how many actions must accurately correspond, to produce the simplest sound; and how many additional combinations there must must be for the formation of articulate voice.

As we may audibly breathe through a trumpet without producing a note of music, so we breathe without the tremor of the glottis to produce voice properly, but only the whisper. To vocalize the breath, there must not only be a certain strength of impulse in the column of air, but there must be an adjustment of the vocal chords in the glottis. The mere impulse of the breath, however forcible, as in sneezing, does not necessarily move the chords of the glottis.

The chordæ vocales being strung by the action of their muscles in correspondence with the forcible expulsion of the breath, they vibrate: this vibration is reverberated on the column of air; and by an adjustment of the passages above, there is a correspondence between the motions of the glottis and the vibrations of the column of air. The breath, thus vocalized, forms the several open sounds or vowels by the change or modulation of the passages: for by the more or less contraction and dilatation of the tube, these sounds are modified; the vibrating air being differently directed, and impelled against different portions of the tube.

The musical notes are in the same way produced by changes in the force with which the voice is propelled, the degree of tension in the chordæ vocales, and the modulation or change in the form of the open passages. There is nothing more surprising than the precision with which the notes of the human voice are produced, as when we hear it rising above the sound of the church organ, the notes more liquid and distinct, and descending in a solfeggio of notes and half-notes, as if each arose from a different pipe, or were struck on a distinct instrument. Yet these falls are consequent on muscular action, which alters the diameter and form of the glottis, and the length and diameter of the pharynx. This minute accommodation of action does not merely evince the perfection of the organ, but shews a most surprising command possessed over it: and in this respect the muscular apparatus of the throat does not yield in comparison with that of the eye itself.

Struck with the perfection of the human voice, its precision, expression, and variety, excelling the finest instruments mathematically constructed, we have more to admire in the production of those conventional sounds which become the instruments of thought and the source of all we know. Articulation results from a still more complex action of the organs of voice. In speaking, the voice is much influenced by the modulation or varying forms of the open passages, before it is articulated in the mouth; whilst with each motion of the tongue or lips there is a correspondence in the action of the velum and pharynx: so that the compression of the thorax, the adjustment of the larynx and glottis, the motions of the tongue and lips, and the actions of the pharynx and palate, must all consent before a word be uttered!

There is one part of the subject which I have omitted in the body of the paper. In speaking, the play of the chest is not the same as in the common act of breathing: the diaphragm is used less, and the ribs a great deal more. A man, preparing to speak, elevates his chest, whilst the abdomen is drawn flatter; the effect of which is to give more play to the elastic cartilages of the ribs, and the falling of the elevated chest is easy and unembarrassed; whereas, to expel the breath beyond a certain degree, requires the action of the muscles of expiration, and makes the act of speaking still more complicated.

When we think of the number of parts which must combine in office to produce the simplest articulate sound, we see the necessity for a corresponding intricacy of nervous connexions, and are less surprised to find the voice defective through derangement of the nervous system. In a person who stutters, the imperfection is obviously in the power of combination, not in the defect of any single part. Whilst he cannot combine the murmur from the glottis with the action of the pharynx, he can speak in a whisper; that is, he can articulate the faint sound of aspiration, whilst he cannot at the same time vocalize the breath. So he can sing his words without hesitation, or impediment, or spasm; because, in singing, the adjustment of the glottis and the due propulsion of the breath by the elevated chest, are accomplished and continue uninterruptedly. Neither does he experience any distress in pronouncing the vowels and liquid consonants, for the same reason: and if he study to commence his speech with a vowel sound, he can generally add to the vibration already begun, the proper action of the pharynx. Another necessary combination distresses a person who stutters, I mean the actions of the expiratory muscles and those of the throat. He expels the breath so much in his attempt at utterance, that to produce a sound at all, the ribs must be forcibly compressed. To remove this necessity, if he be made to fill his lungs and elevate his shoulders, the elasticity of the compages of the chest will come into play so as to expel the breath without effort, and he will speak with comparative facility and comfort. Accordingly, to commence speaking with the chest fully inflated, to pitch the voice properly, to keep a measured time in speaking, and to raise the voice on a liquid letter or vowel, are some of the common means recommended for the cure of stuttering; and they are certainly those which tend to overcome the difficulty of combining the organs of speech when the defect arises from no disorder or malformation of these organs taken separately.

I have only further to hope that, by the interest which this subject is capable of exciting, I may be indulged in a subsequent attempt to unravel the nerves of the neck and throat.

EXPLANATION OF PLATES XIII, XIV, XV.

PLATE XIII.

This Figure represents a section of the face and throat, exhibiting the organs of the voice in one view.

A The trachea.

B The chorda vocalis of the right side: above it we see the sacculus laryngis.

C The arytenoid cartilage, which being moved by many muscles, changes the condition of the ligament or chorda vocalis.

D The epiglottis, which falls like a valve over the glottis, as the morsel passes in swallowing, but which is important to the voice as directing the stream of vibrating air upon the fauces.

E The bag of the pharynx, that cavity into which the sound is directed, and by the contraction of which an appulse is given in articulating certain consonants.

F The uvula and velum palati, which, acting like a valve, and closing the passage upwards into the cavities of the face, throw the force of the contracting pharynx forwards into the mouth.

G The cells of the bones of the face, through which some sounds are produced by reverberation.

H The palate, the roof of the mouth, and floor of the nasal cavities.

I The tongue.

All the dark or shaded parts of the figure marks the extent of the cavities employed in the formation of the voice.

PLATE XIV.

Fig. 1. The larynx and trachea seen in front—in outline. The thyroid gland is shaded.

A The thyroid cartilage.

B The cricoid cartilage.

C The trachea.

D D The thyroid gland seated below the larynx and embracing the upper part of the trachea.

Fig. 2. Represents a section of the larynx and part of the trachea.

A The thyroid cartilage.

B The cricoid cartilage.

C The arytenoid cartilage: on the top of it we see the surface for the articulation of the appendix.

D The cartilaginous rings of the trachea.

E The superior thyro-arytenoid ligament extending from the thyroid to the arytenoid cartilage.

F The lower thyro-arytenoid ligament or chorda vocalis. Between these ligaments is formed the sacculus laryngis.

We perceive how the numerous muscles attached to the arytenoid cartilage, eight in number, must affect the ligament and alter the chink of the glottis.

Fig. 3. A portion of the trachea cut out to shew the transverse muscle.

A The transverse muscle.

Fig. 2.

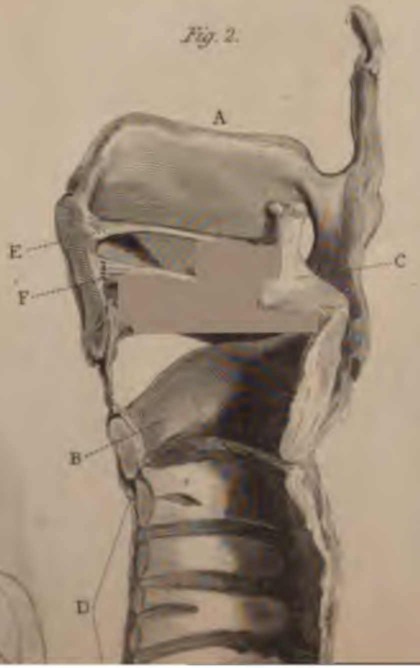


Fig. 1.

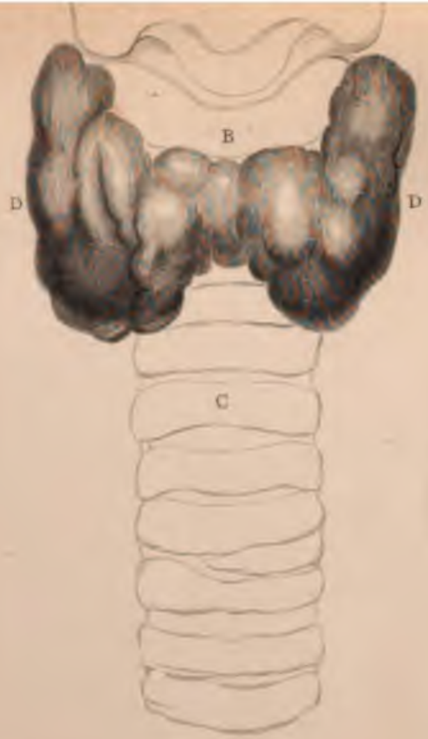
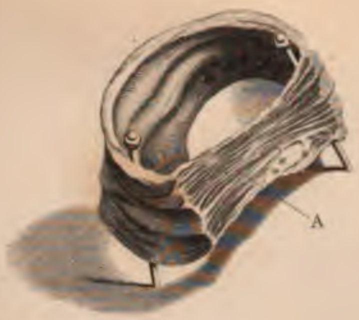


Fig. 3.



Sir Charles Bell del.

J. Basire sc.

PLATE XV.

Fig. 1. A transverse section of the spinal marrow, shewing the distinctions of the medullary and cineritious substance.

Fig. 2. Shews the section with the medullary columns parted at their natural divisions, viz. by insinuating the curette into the cineritious substance, and opening the sulci.

A The posterior column.

B B The lateral columns.

C The anterior columns.

Fig. 3. The same parts still farther separated, so as to exhibit the connexion between the posterior columns of the spinal marrow and the motor columns. The letters refer to the same parts as in the last figure.

D The connexion between the posterior and anterior columns.

Fig. 4. In this view the posterior part of the spinal marrow, that which belongs to the cerebellum, is taken away, leaving those columns only which belong to the cerebrum. As the posterior portions (Figs. 2. and 3. A) enter deeply into the spinal marrow, when they are taken away the remaining columns fall flat on the board, and permit an easy separation.

A A The cineritious matter which intervenes between the columns belonging to the cerebrum, and those belonging to the cerebellum.

B Projecting lines where the posterior columns of the spinal marrow were connected with the anterior. (See Fig. 3. D.)

C C The lateral columns, or sensitive columns, after raising the cineritious substance. Into these the sensitive roots of the spinal nerves are traced.

D D A deeper dissection of the cineritious substance exposes here the the posterior surface of the anterior or motor columns.

Fig. 5. This figure represents a posterior view of the upper part of the spinal marrow, and the medulla oblongata.

A The two posterior columns of the spinal marrow being dissected up, they are here represented diverging towards the cerebellum at G.

Fig. 1.

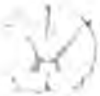


Fig. 2.

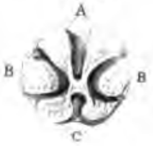


Fig. 3.

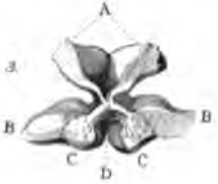


Fig. 4.

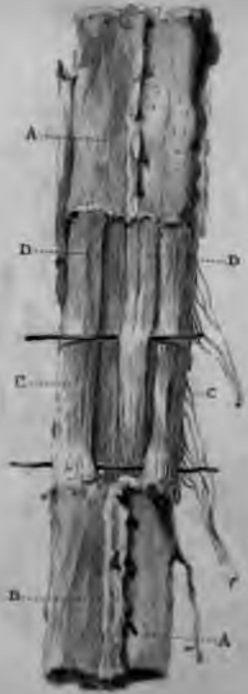


Fig. 5

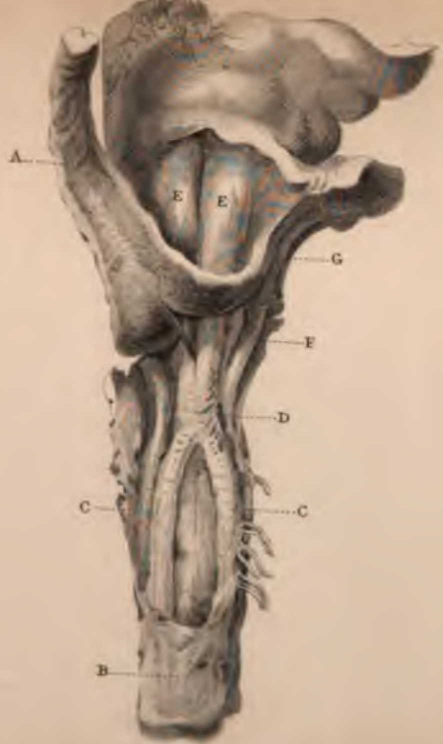
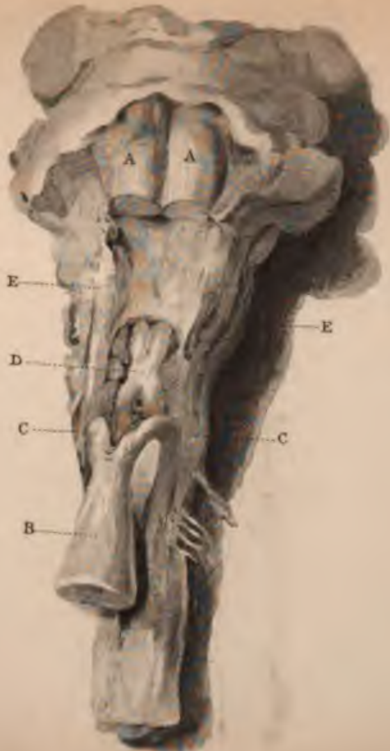


Fig. 6



B The cineritious matter left on the remaining part of the spinal marrow, after raising the column (A). The separation of the columns having been made at the intervening cineritious matter, both surfaces have that matter attached to them—both A and B.

C C The lateral columns of the spinal marrow (Figs. 2. and 3. B B) displayed on their posterior surface. They are discovered on raising the cineritious matter B. Into these columns the posterior root of the spinal nerves are traced: they are the columns of sensation.

D The short column formed by the union of the columns C C. On dissecting this portion, the decussation of the columns will be seen.

E E The same columns which were lateral in the spinal marrow, now continued upwards, and visible in the fourth ventricle without dissection. They ascend under the valvula cerebri and under the corpora quadrigemina, and fall into the crura cerebri. So that, tracing them from above, each of these columns descends from that part of the crus cerebri which is posterior to the corpus nigrum.

F The origin of the sensitive root of the fifth nerve of the encephalon.

G The processus cerebelli ad medullam oblongatam.

Fig. 6. This figure represents the further dissection of the parts seen in Fig. 5.

A A The columns marked E in the former plate. They are divided transversely, and the lower portion folded down, being separated from the parts below by a delicate dissection.

B These columns folded down.

C C The lateral columns of the spinal marrow continued up into B.

D The union of the anterior columns seen in their posterior aspect. The lateral or sensitive columns, and the anterior or motor columns, are held together at this point. But it appears more for security than reunion. A fine dissection exhibits them quite distinct; and the parts above continuous into the columns of the spinal marrow; each separately.

E E The sensitive roots of the fifth pair of nerves.

FINIS.

THREE PAPERS

ON THE

NERVES OF THE ENCEPHALON,

AS DISTINGUISHED FROM THOSE ARISING FROM THE

SPINAL MARROW.

From the Transactions of the Royal Society of Edinburgh.

ON THE NERVES OF THE ENCEPHALON

(*Read 2d April* 1838.)

It is not a little remarkable, in an age which assumes to itself the character of devotion to science, that, in anatomy, a science which embraces the best interests of humanity, this question should remain unanswered; *What is the meaning of the nerves of the spinal marrow being in regular order and perfectly symmetrical; while the ten nerves arising from the brain present no similarity one to another, and agree neither in origin, in size, nor in distribution?*

It is plain that we must be in the dark, not only with respect to the knowledge of the nervous system, but of the animal frame generally, while such a question is open and courts inquiry, and yet remains without an effort being made towards its solution. We must, I fear, attribute this neglect in part only to the difficulty of the inquiry, while much is owing to the indifference to all that does not tend directly to profit; on which account it has the better demand on the attention of a learned and philosophical society.

So far back as the year 1811, I ventured to announce this principle, *that in the nervous system a filament possesses the same endowment, and performs the same function through its whole course, whether that filament be in a nerve, or traced from the nerve into the spinal marrow, or from the spinal marrow into the brain.*

The truth of this is apparent as soon as expressed; and inquiries directed on this principle have given it countenance and importance. It enabled me to shew that what was called a common nerve, being such as was supposed to possess all the vital properties, consisted of two nerves joined in the same sheath—one presiding over motion, and the other the seat or organ of sensation. Following out the principle, I found that the roots of the so-called "common" nerves, differing in function, arose from distinct columns of the spinal marrow, and that these columns corresponded with the roots of the nerves to which they gave origin: that is to say, that the anterior of these columns presided over motion, and the other over sensation: That they were distinct, but not separated in their course, and that they preserved their parallelism and resemblance even till lost in the cerebrum. For at the point where the anterior columns join, and decussate in the medulla oblongata, a similar junction and decussation takes place between the posterior columns.

In tracing these columns upwards, we come on ground necessary to our present inquiry, viz.—the *Nodus Cerebri* or *Pons Varolii*. This most conspicuous part of the base of the brain is an intricate mass of fibres, whose commissures and columns are interwoven, and to what purpose? Can it be doubted that it is for the purpose of general union?—in order that organs seated apart may be united through the connection of their nerves?

Below the *nodus*, the course of the columns is regular; above it, the course of the corresponding tracts is simple. Here, then, must be seated the mystery; since, but for this intricacy in the *nodus*, order and simplicity would be displayed throughout the whole nervous system. We are directed in this inquiry by another circumstance. When we consider the nerves of the Encephalon according to the enumeration of Willis (which hitherto has been the acknowledged system), and count them and describe their course, we find *six sent to the eye!* The 2d, 3d, 4th, 5th, 6th, and 7th, wholly or in part, pass into the orbit; into a space not larger than a wallnut shell. It is obvious, that if we can discover why these nerves crowd into the orbit, the reason of the variety in the nerves of the base of the brain must also be disclosed to us.

This consideration points to the organ which has most engaged philosophers of every age and country —the human eye.

There are many reasons for considering vision as the compound operation of the sense seated in the retina, and the sensibility to the muscular movement of the eyeball. But without entering upon this demonstration, it is sufficient to our present purpose that we observe the surprising power of muscular adjustment of the eye in the direction of its axis to the sensation in the retina, or in other words, to the object contemplated—as when the attention is directed to the minutest speck,—or when the eye follows objects in motion, the flight of a bird or the track of a bombshell.

Since, then, the relation between the motions of the eyeball and the sense enjoyed by the proper nerve of vision is intimate beyond all comparison, and, I I had almost said, comprehension, our first inquiry may take this shape—Ought the motions of the eye, so necessarily conjoined with the proper sense of vision, to be trammelled by the complex relations of the general frame?—those motions which, from familiarity, appear the simplest possible, but which are in fact the most complex. There is not a muscle in the body, nor a system of muscles, in which combination, to a very great extent, is not necessary to action.

The spinal marrow forms a system through which the whole body, and especially the four quarters, are combined in action. There is not a limb stretched out without a conforming motion and balancing of the whole body. Walking, running, leaping, swimming, exhibit instances of this combination of the limbs, and of the trunk in consequence. The whole active machinery of the frame is combined in most intimate union.

If we consider the office of the eyes—the necessity for free and uncontrolled motion—their sole dependence on the sensation in the retina—we shall be ready to acknowledge that they must be relieved from the train of concatenated actions which occurs in every movement of the frame besides. Thus unembarrassed, the *recti* muscles of the eye are suited to that sympathy, and that extraordinary minuteness of accordance with the state of sensation in the retina, which are necessary to vision.

Resuming the consideration of the columns of motion and sensation :—they may be traced up into the cerebrum ; the great *crus cerebri* is formed of these combined columns, as each diverges, and is lost in the hemisphere. The column of motion is still anterior, so that the anterior part of the crus belongs to muscular action, and the posterior part to sensation.

Now, considering that the essential difference in these columns is this—that in the anterior, the course of impulse is outward from the *sensorium commune*, and that it is inwards, or towards the sensorium in the posterior, the origins of all the nerves must be conformable, or the system is overthrown.

We look with increasing interest on the roots of nerves, as conclusive on this subject.

The *first* nerve, the olfactory, being traced backwards, divides into three roots, and disperses in the inferior part of the anterior lobe of the cerebrum, without the intervention of the columns, and without interference with them.

The *second* or *optic* nerve, though in direct contact with the column of motion, takes no origin from it; but in a long and circuitous course, under the name of *Tractus opticus*, turns round the *crus cerebri*, to fall into the rear or back part of the column of sensation; and so, is combined with those nerves, through which the impulse is towards the sensorium, or inwards.

Even on proceeding so far, it is fair to infer that a nerve of sense gives off no branch—that it can communicate no endowment—that it is unable to confer either motion or sensation, or any property but that which is its limited office.

Further, if we take the pen, and trace the nerves of sense—the olfactory, optic, auditory, and gustatory—we shall find them all avoiding the anterior column, and falling into the back part of the sensitive column; so that already in part we perceive the cause of irregularity in the base of the brain, in the necessity of the nerves of sense avoiding the anterior column, to gain the posterior or sensitive column.

We come next to the *Third Nerve.* This nerve is distinguished from all others; its origin is peculiar, and its distribution limited. By universal consent, it has got the name of *motor oculi*, being distributed to

the voluntary muscles of the eye, and to none other; so that it directs the axis of the eye in vision; con-
9 trolling the muscles, and having the further property of conveying to the mind the impression of the condition of the muscles. I entertain this idea because it is a double nerve.

Its origin.—Our best authors describe this nerve as arising from the *crus cerebri;* and so it does, above all the intricacy of the nervous system. It does not enter into the mixture of originating filaments in the *pons* or *nodus.* It does not communicate with the decussation in the *medulla oblongata.* It is in direct communication with the brain. But its precise origin deserves more particular inquiry.

As I have elsewhere shewn, that the *crus cerebri* consists of two columns, one of motion, the other of sensation, and that the *corpus nigrum* divides these columns; if a section be made of the *crus,* just anterior to the origin of the third nerve, we shall find that we cut through the *corpus nigrum.* And now if we take the curette, and gently divide the two columns, and so separate them in the direction towards the root of this nerve, we shall divide or split it, shewing that part of it arises from the anterior column, and part of it from the posterior column. If we carefully dissect and lay out the third nerve, we shall have a very interesting view, as illustrative of its function, and of the nervous system in general. The roots, as they arise, and for some way in their course (see Plate XVI, Figs. 1 and 2), are in round distinct cords, running parallel to each other. They then join together, and form a dense body, in which the filaments are separated, rejoin, and are matted together, after which their progress is as a common nerve.

Their distinct origin from the divisions of the *crus*—the two distinct fasciculi of parallel fibres—the course of these for some way without exchange of filaments, and then afterwards running into intimate union—are circumstances of much interest, as shewing the distinction of the *crus cerebri*, the distinct nature of the roots of the third nerve, and that it is a double nerve, dedicated to the finer motions of the eye, peculiar in its structure, and yet in conformity with the system which I have followed.*

The question is naturally suggested here, Is the third nerve a sensitive nerve, as well as a motor; and if so, how comes it that there is no regular ganglion on the root which it receives from the sensitive column?

This would incline me to believe, that the ganglionic root is an organization on the spinal nerves and fifth pair, suited to that sensibility which the body universally and the surface especially enjoys, which gives pain, and becomes a guard upon the frame.

At the same time, it will not be overlooked, that the texture of the nerve at the union of the fasciculated roots very much resembles the texture of the spinal ganglion (Fig. 2, D). The difference may be reasonably attributed to the distinction in office, viz. that it has no reference to the sensibility of the surface, but only to the condition of the muscle.

The very peculiar and unique position of the roots of this third nerve, while it places the function of volition directly in communication with the sensorium, and unembarrassed by communication with other nerves, has also this superior advantage, that it is in direct relation to the sensitive column. This connection, as I have just said, has no reference to common sensation, for the nerve is strictly limited to the muscles, but only to the property of estimating the condition of muscular activity.

---

* The objection which will be naturally suggested is, that the *abducens* nerve arises behind the *pons*. We shall afterwards shew why it does so. And, let it not be forgotten, that the relations of this nerve are the cause of frequent disturbance to the condition of the eye, a consequence, certainly, of its greater complexity.

We pass on to the consideration of the Fourth Nerve. To comprehend its relations, we must take a wide range, and a different course.

PART II.

OF THE ORIGIN AND COMPOUND FUNCTIONS OF THE FACIAL NERVE, OR PORTIO DURA OF THE SEVENTH NERVE.

(*Read 9th April* 1838.)

In following out the principle formerly laid down—that the study of the organization and functions of the part to which the nerve is distributed, will explain the peculiarities of its origin and connections—I have in this paper entered on a subject of great extent and difficulty.

As the *Facial Nerve* is one of a distinct class, it will be necessary to shew in what that class is peculiar—that it essentially belongs to the act of breathing—that the act of respiration being, in its ordinary condition, independent of the will, there are nerves appropriated to that function. At the same time, as the apparatus of breathing is made subservient to other purposes in the economy, it must be shewn by what relations it is brought under the influence of the will.

The excited act of breathing extends to the features of the face; and the face, so influenced, is especially the seat of expression. But the parts thus influenced are also instruments of speech. Hence, it appears, that the nerve which animates the features must have a compound root. It will be my object to shew that the facial nerve has an origin corresponding with its complex operations.

It has been said that I have given up the term

Respiratory Nerves. This betrays an ignorance of the whole subject. But as it may have arisen from my imperfect description, I beg the Society to permit me to illustrate this subject, as the necessary foundation of what I have to offer on the nerve of the face. In an inquiry of this kind, the observation of natural phenomena is more agreeable, and more conclusive, than experiments on living animals. With this object, let us notice the actions of the frame at a time when sense and volition are withdrawn.

It is sometimes the severe duty of the physician to watch the act of dying, and to mark its successive stages. A man is not dying, whilst yet the respiration is unembarrassed. But whether he die from violence and loss of blood, or by gradual exhaustion and lingering disease, the act of dying may be said to commence with an excited state of the respiratory organs.

When the vision is clouded, and the eyes want speculation or direction, and the hand is insensible to the pressure of affection, then the chest rises high at each inspiration, and the muscles of inspiration are prominent in action.

When, through increasing insensibility, the limbs lie relaxed and powerless, the muscles of the shoulders, neck, throat, and nostrils, are visibly excited, and at each inspiration (although we cannot say there is effort, that being an influence of the mind), yet each fibre of the class of respiratory muscles is like a cord in violent tension.

When the decay of life reaches the respiratory system, it first affects the lesser muscles which expand the air-tubes; the muscles of the *glottis* and *velum palati* lose their tone; and these parts becoming relaxed, vibrate in the inspiration of the breath, and cause stertor.

At length the regularity of the respiration is disturbed—there is an interval between the inspirations—the interval is prolonged and irregular; and the action returns with sudden violence, every muscle starting convulsively into action, but with no voluntary effort or struggle. The longer the interval of rest, the more sudden and startling is the return of action, and when we deem all at rest, once more the breath is drawn. At last the action ceases in the chest, while yet the throat and cheeks are pulled with a regular succession of actions, and the last fibres which answer to the presence of life, are the *Risorius Sanctorini* and muscles of the nostril. Two or three times the *Risorius* is drawn with spasmodic twitchings, and then all is still. It is the ultimum moriens.

We can hardly fail to perceive the resemblance here to natural sleep; the absence of all sense and voluntary motion, and the continuance of the respiration by a property of action which knows neither lassitude nor debility.

In a Society which does not reject the cultivation of literature with science, I may be permitted to quote the beautiful description of Haller:—" Nocte redeunte sensim torpor percipitur in musculis longis, ineptitudo ad cogitationes severiores, amor quietis in animo et corpore. Tunc peculiariter vires corpus erectum tenentes laborant, et oculi nolentes clauduntur, et maxilla inferior pendet, et oscitationis necessitas ingruit, et caput antrorsum nutat, et objectorum externorum actiones minus nos adficiunt, et denique turbantur ideæ," &c.

But, whilst the body, as far as it is subject to the mind, or subject to change through the will, or through passion, is thus at rest, a class of muscles of great extent, seated remote from each other, are combined in simultaneous action. No weariness or exhaustion reaches them. They are most perfect, most regular in action, whilst all besides are at rest.

Thus, we may contemplate the body under two conditions: *First*, Where all is animated, sensitive, and expressive: *Secondly*, Where the body has the semblance of death, and the active powers are at rest. It is natural to seek in the anatomy, and especially in the nervous system, for some correspondence in the structure: nor shall we have far to seek.

Having distinguished that symmetrical system of nerves, the functions of which are sensation and volition, we find nerves which at first appear superfluous. But these superadded nerves, although they produce, when entangled with the others, the appearance of extreme intricacy, are, when taken separately, regular also. For we trace all to a centre, and we find that centre giving them an origin and a source of power different from those of the other nerves.

When we see to what order of parts these nerves are distributed, it is impossible to refuse to them the term of Respiratory Nerves. The distinction of animal functions from vital and natural, has always been acknowledged, and the distinction explained on the supposition of distinct nerves ministering to each. This explanation was resigned, because anatomists would not agree to any such distinction of nerves. Nevertheless the reasoning was just, and the objection of the anatomists unfounded.

Comparative anatomy affords us the most pleasing view of this respiratory system. From the lowest link of the chain of beings to the highest, there is a progressive series of nerves, increasing in complexity. It is natural to inquire, On what does this complexity depend? In the lower link of the chain of animals, we see the essential operation of decarbonization performed by the contact of air with the fluids circulating over all the frame. We see the same object attained in others by a sac or cavity, which admits the air, and which sac alternately opens and closes again. In other creatures such cavities communicate with the atmosphere through prolonged and intricate tubes. Witnessing all this, we also perceive the necessity of new nerves of connection. When we further see a new power or faculty bestowed by means of the air which plays through these tubes—voice issuing by their vibration; when we observe that the air drawn through the tubes is diverted into another channel, and made subservient to smelling; when, still ascending to the highest link of the scale, we find the faculty of speech bestowed through the same means,—it would be strange, indeed, if anatomy did not, in the same ascending scale, disclose an increasing number of nerves.

Again, in the mouth and in the throat there are two passages. How shall the one only admit air, and the other food? How shall breathing, deglutition, and speech, coughing, vomiting, be performed, each action differing from another, in the arrangement of some fifty muscles of these tubes? How are these actions ordered, but by a minute and seemingly intricate supply of nerves?

In all animals, man included, the same symmetrical system of nerves, unvarying in any essential circumstance, is devoted to sensibility and locomotion.

But the other system, that which is superadded, varies in a remarkable manner; comparatively simple in the animals which merely breathe; complex when the organs of breathing become instruments under the will, they are at once essential to life, and in their higher office minister to the qualities of mind. It would be a strange anomaly, if, with these new faculties, sympathies, and relations, there were not also an increasing complication of nerves. This intricacy, this fine dependence of the functions, renders experiments delusive and unsatisfactory. For we may divide a nerve, one which appears to our conception essential, and no visible consequence results! We cut a nerve going to the tongue or the throat, and yet the animal breathes, barks, and swallows. It would be dangerous therefore to conclude that the nerve were superfluous. It is only by an enlarged view of the anatomy that we shall be brought to just conclusions.

From this system I have to select one nerve, and shew how, through it, two distinct offices—vital respiratory actions, and voluntary actions—are combined in the face.

The base of the brain being carefully taken out, without tearing the roots of the nerves, and the whole being for a twelvemonth preserved in spirits, we may commence the dissection. The *medulla oblongata* and *pons varolii* being cleared of their membranes, and the places of the *sixth* and ninth nerves noted, we clear and arrange the filaments of the eighth pair, and the *portio dura* of the seventh.

We see the *facialis* or *portio dura* of the seventh nerve coming out from the depth between the convexity of the *pons* or *nodus cerebri*, the *corpus olivare*, and the root of the auditory nerve. This nerve we have now to trace inwards, and in the substance of the *pons* or *nodus*.

We shall not find this nerve arising in separate filaments, but in a flat layer of nervous matter, which, fan-like, spreads into the nodus.

To understand the full consequence of this form of the root, we must make a section of the *nodus* or *pons*, to shew the manner in which the motor tract expands within it. Previous to this let the sixth nerve, and *portio dura* of the seventh, be thrown forwards, and the glosso-pharyngeal and nervus vagus laid aside. If we now dissect close round the corpus olivare, the motor column will be found bending round that body; and now, by following the root of the *portio dura* inwards, its origin from the column of voluntary motion will be apparent; one portion diverging towards the sixth nerve, the other towards the glosso-pharyngeal nerve. See Fig. 3, (6, 7, and 8,) also Fig. 4, in which the relations of the nerves are made more distinct. By proceeding differently, we obtain a better view of the common origin of the eighth pair and *portio dura*. Cut across the *processus ad cerebellum*, and open up the fourth ventricle. Trace the roots of the eighth pair inwards. You find the column from which they arise in the form of a *tractus* ascending to the *corpora quadrigemina*, the *valvula cerebri* forming the commissure of the two respiratory tracts. From this tract the *portio dura*, now viewed from behind, will be seen to take an origin.

We may now have a view of the relation of the respiratory nerves to the sensitive column of the *medulla oblongata*, either by tracing up the sensitive column from the spinal marrow, or by tracing down the sensitive root of the fifth nerve. We shall now find that the eighth pair, that is to say, the *nervus vagus* and *glosso-pharyngeus*, is situated so as to draw roots from the sensitive column.

By such a mode of dissection, it will be found that the facialis or *portio dura* of the seventh nerve has direct connection with the motor and respiratory columns, and is hardly less directly related to the fourth and sixth nerves.

The facial nerve, thus arising, allies itself with the auditory nerve, and passes into the temporal bone. In its passage through that bone, it exchanges fibres with the branches of the fifth nerve, and after some intricacies, escapes by the *stylo-mastoid foramen*, to expand upon the cheek, and finally to reach every part on the side of the head, with the exception of the muscles of the jaws. Although its connection on the side of the neck countenances the view I am about to give of this nerve, yet we must draw our inferences chiefly from the origin and functions of the nerve.

OF THE FUNCTION OF THE FACIAL NERVE, OR PORTIO DURA.

In the facial nerve we have an organ of the most complex operation. It combines the passages with the great internal organ of respiration. It animates the lips and cheeks in combination with the organs, so as to give both speech and expression. It is the source of all the sympathetic actions which illuminate the features in unison with the condition of the mind. It has some remarkable effects on the eyes, which subject we shall reserve to be taken apart from the present inquiry.

That the facial nerve is the respiratory nerve, I early shewed, by dividing it in brutes; when, although sensibility remained, all action in the face was cut off, excepting the motion of eating. Many occurrences in the practice of my profession have exhibited the same results from the same cause in man.

Though one of the most celebrated philosophers of our day, Dr Young, asked rather querulously, "What had the face to do with respiration?" yet must it be obvious (unless, indeed, to those whose minds are exclusively engaged in observing the chemical phenomena of the economy), that the tubes which give passage to the air, being soft and pliant, and subject to the pressure of the atmosphere, must be dilated, and their sides held apart, by muscular action. How else are they to admit of breathing? And more especially, how is the expansion of the tubes to be adapted to the excited condition of breathing? I have already alluded to the stertor consequent on the relaxation of the tubes in apoplexy. And when this nerve is deprived of power, we find the relaxed lips playing in the act of breathing like the flapping of a sail.

It will not therefore be again asked, why a branch of that system of nerves which animates the organs of respiration extends to the lips and nostrils, as other branches tend to the *velum palati*, the throat and larynx.

Considering the nerve in this, perhaps its most important function, that is as operating upon the tubes or passages for the breath, during sleep and insensibility, we have next to contemplate it, as combining the effort of the will in unison with that of respiration. It is in this combined exercise that we have to be most grateful for the effect,—the vibrations of the tubes modulated into articulate language,—the performance at once of that function most necessary to existence, and that faculty of speech essential to the development of the powers of the mind as the *instrument* of thought.

Finally, the facial nerve is the source of expression. If the properties of this nerve by any accident be lost, accidentally cut across, pressed on by a tumour, or engaged in inflammation, the corresponding side of the face remains motionless and blank. The cheeks and lips are blown up like a window-blind. They have neither tension nor action. *Expression*, whether in laughter or in tears, and all the intermediate conditions, continue to influence the other side of the face, but with frightful distortions pulling upon the side which has lost power.

There are instances recorded, now that the cause is understood, of entire loss of expression on *both* sides of the face. A young woman, in whom the roots of the nerve on both sides were involved in disease, exhibited the most distressing consequences, —for whether she laughed or cried, the features were immoveable. She laughed under a mask; a sad thing to witness, a light heart behind a face in the repose of death.

There is an animation coincident with speech, and a reflection of the mind in the human countenance, *at all times*. We have the full sense of this only from the effects of this nerve being cut, for then the features are completely fallen, more divested of expression than a mask or a bust, for it is not as the fixed state of a *statue* which has *meaning*, but something worse than death.

If this condition of total inaction continue, the plumpness of the face is lost, and the skin becomes like a piece of parchment stretched over the bones. It is a remarkable thing to see, in one sense, the life and sensibility of the parts remaining, whilst there is a ruin of all that can reflect the mind. The muscles of the jaws, however, remain as powerful and active as before, their energies being excited through the nerves of the other system.

We now perceive the correspondence between the roots of the facial nerve and the offices which it has to perform in the face. We recognise its double roots, its relation to two distinct columns in the performance of two distinct functions. We perceive its lively subjection to the will, because of its relation to the motor column, while its origin in common with the eighth pair of nerves explains to us how it is that the nostrils and lips move simultaneously with the other parts engaged in the act of respiration; in other words, how the vital actions through the influence of this nerve are continued during the repose or annihilation of sensation and volition.

It is not possible to account for all the finer operations of the features by the investigations of anatomy. Yet we see that this nerve arises in most peculiar circumstances; that its roots are connected with the *nodus cerebri*, a name well chosen, since in it, without exaggeration, fibres are crossing in every possible direction. We may display these fibres, and we may suppose that each filament has its influence; but it is better to stop short of conjecture, and to rest on the demonstrated fact that this nerve is special; in one sense a double nerve; not, however, like the double nerves of the spine, where action and sensibility are conjoined, but double in as far as two modes of action are effected through it; one independent of mind, the other answering to its slightest emotions.

There is indeed nothing more remarkable than those distinct offices, and that variety in the motion of the features, arranged and controlled through a single nerve not larger than a thread, combining the features in the general act of respiration, giving utterance in speech, and indicating every degree and variety of emotion.

I had at one time been deceived into the belief that laughter, and all the changes of the face indicative of what is pleasurable or ludicrous, were but the result of the degress of relaxation of the muscles; as it were a defect of action. Such an opinion is untenable when we perceive the consequences of the loss of this nerve; for its defect of influence, so far from giving place to a smile, reduces the features at once to the most painful and melancholy relaxation.

Laughter, and all the changes of the countenance indicative of pleasurable emotion, are neither the effect of relaxation nor of spasm incidentally produced. They arise from a balanced condition of the features, in which certain muscles are in activity, whilst others are thrown out of action. In the painful emotions, still influencing the features through the same nerve, another classification of muscular actions takes place; some muscles in tension, others incontrollably relaxed; both conditions, and all the intermediate states, are designed as the outward signs of passion; from which are afforded the highest and the most un-ceasing gratification, a language which is the charm of life, and the bond amongst men.

But I am somewhat trespassing, and deviating from the proper object of the paper, which was to shew in what the facial nerve or *portio dura* is distinguished from the symmetrical nerves—that it is in a different sense a compound or double nerve, and that its roots correspond so far with its various functions.

In my next paper, I shall endeavour to shew the necessity of combination between the Facial Nerve and those which enter into the orbit.

PART III.

ON THE FOURTH AND SIXTH NERVES OF THE BRAIN.

(*Read 7th May* 1838.)

Interesting as the optical properties of the eye have been to philosophers in every age, there are conditions of this organ which are no less curious, and yet have not had their share of attention.

In the year 1823, I introduced the subject to the Royal Society of London, nearly in the terms which I am now using; but there is much more in the subject than I then conceived, although I see no reason to change the mode of contemplating it.

The eight muscles of the eye, and the five nerves, exclusive of the optic nerve, which pass to them, imply the complex nature of the apparatus exterior to the globe, and I fear it is too plain that the subject has not been satisfactorily treated.

It is chiefly with respect to the protecting motions of the eye that the difficulty occurs, for I hope the dependence of the proper organ of vision on the voluntary muscles of the eye, has been proved and acknowledged.

Permit me to draw the attention of the Society to what appears a very simple piece of anatomy, the circular muscle which closes the eyelids, *orbicularis palpebrarum*.

It will be necessary to divide the muscle into three parts—and that not in an arbitrary manner, but according to the action of each division.

Around the margin of the orbit, there is a portion of the muscle red, fleshy, and strong—within it, and lying on the eyelids, there are fibres, which, though they converge to the same point in the angle of the eye, are distinguishable from the outer circle by their delicacy and paleness. Lastly, the *ciliaris* is a thin slip of muscle which lies along the margin of the lower eyelid.

These divisions of the muscle authorized by Albinus and others, have different actions and different relations. The larger and external circle is brought into action when the eye is irritated or excited. The lesser paler fibres gently close the eyelids as in sleep, or in winking when the eyelids fall together in their usual rapid closing, to moisten the surface of the cornea,—an action which is quite peculiar, and so quick as not to interfere with the permanence of the impression on the retina.

The ciliaris draws the lower eyelid horizontally, and belongs properly to the *sacculus lacrymalis*, squeezing and emptying the sac.

Let us observe the necessity of certain relations between the larger and fleshy circle of the orbicularis when the eye is excited; as when anything offensive is thrown into it. It is here necessary to notice the resemblance in action of the human eye to that of quadrupeds which possess the *haw*.

In the *caruncula lacrymalis* and *membrana semilunaris*, we have an apparatus less perfect, certainly, than that of the horse—but for the same purpose, to gather together and thrust out what is irritating the eye.

To the exercise of these parts, however, other muscles must consent, so that the cornea shall be turned in towards the inner *canthus* of the eye at the moment that the eyeball is forcibly squeezed by the action of the orbicularis. The difficulty which the oculist encounters, is to prevent the cornea from turning in to the lesser angle of the eyelids; for this direction of the eye towards the nose, takes place the instant that the knife or needle touches the eye. This action of the muscles, which is a provision for the protection of the eye, is often the source of mishap in operation.

The position of the eyeball in which it is drawn towards the *os planum*, and the axis turned inwards, could not be the effect of the external orbicular muscle alone—nor could it be performed by the combined action of the recti. It is obvious that a relaxation must take place in the *rectus externus* or *abducens* muscle. How is this relaxation to be effected in correspondence with the action of the larger or outer portion of the *orbicularis?* There is no direct connection between these muscles: they do not touch: no nervous filaments pass between them. We must therefore turn to the origins of the nerves which supply these muscles. We find them related at their origins, though proceeding by different courses to their destination.

Here let us consider the nature of that relation which exists between two classes of muscles engaged in any action. I mean not those only which are excited together to contraction, but those also which are relaxed, and which relaxation is as necessary to the effort or movement, as the contraction of their opponents.

In every action there are two conditions of the muscles; and philosophically considered, both might be called states of action, for that which is called relaxation is not like the throwing loose of a rope which gives no resistance, but a condition of yielding, proportioned in the finest degree to the state of contraction of the other class.

This relation established between the two opposite classes of muscles is not always as in the limbs where they lie in juxtaposition,—but often, more especially where the muscular action is related to the internal functions, muscles may be far apart, which yet through nervous connection are in intimate correspondence, though in opposite conditions; the one contracted, the other relaxed.

And now as to the motions of the eye, we cannot be surprised if the muscle exterior to the eyelids, and the muscle lying deep in the socket, should be related in the condition of relaxation and contraction, and that the relation should be established through the connection of their respective nerves at their roots—this is the matter to be inquired into.

Let us now attend to the relation of the lesser portion of the orbicular muscle—that paler set of fibres which lies on the eyelids.

When we recollect that the margins of the eyelids in closing, touch only at their outward edge, and that when closed, a gutter is left between them and the cornea, we see that the winking of the eye, far from clearing the surface of the cornea, would suffuse it, by leaving the tear upon it, were it not that in the act of winking the eyeball is turned up. It is by this revolving of the ball that the cornea is moistened and wiped clear.

How is this revolving motion of the eyeball accomplished? No action of the eyelids could produce this effect. It can only be done by the action of the superior *rectus* or inferior oblique. It is not performed by the superior *rectus*, which I determined, by cutting that muscle in a monkey, when the upward rolling of the cornea continued accompanying the effort of the eyelids to close.

The two oblique muscles being opponents, the relaxation of the upper one will give power to the lower one, so that we have, as before, to seek for a relation between the paler fibres of the *orbicularis* and the superior oblique. The superior oblique stands in the same relation to the internal and paler circle of the *orbicularis* that the *abducens* or *rectus externus* does to the stronger exterior circle of the same muscle.

Thus brought to acknowledge the relation between the muscle seated on the eyelid and external, to a muscle seated deep in the orbit, and seeing no direct connection between them, we must turn once more to notice the relations which establish the connection at the roots or origins of their respective nerves.

By such study of the muscular apparatus of the eye, and their actions for the protection of the organ, we are following out the principle, that the structure and action of a part will direct us to the peculiarity of its nerves. That the eye stands distinguished from the other organs of sense by the multiplicity of its guards, is owing to its extreme delicacy of structure, and its necessary exposure.

In my second paper, I had occasion to notice that the *facial nerve*, or *portio dura* of the seventh, coming circuitously through the *foramen stylo-mastoideum* to supply the face, is the nerve also of the *orbicularis palpebrarum*, or, in other words, of the exterior muscles of the eyelids. It was also noticed, that the *fa-*

cialis at its origin is in direct relation with the sixth or *abducens* nerve. Now, this sixth nerve takes a direct course forwards into the bottom of the eye-socket, crosses all the other nerves, and, though crowding with them into the orbit, forms no relation with them, but is altogether given to the abductor muscle.*

Again, in following the root of the *facialis*, and especially that portion of it which arises from the respiratory tract, we find a relation established between it and the root of the fourth nerve or *trochlearis;* and this delicate nerve passes forward like the other, enters the *foramen lacerum*, and gains the bottom of the orbit, touches no other nerve, but is wholly given to the superior oblique muscle.

If an objection should be made to the circuitous course of these nerves, as the source of the relations between the muscles, how else are the sympathies to be accounted for? and what interpretation are we to put upon the fact, that wherever there are *recti* and *obliqui* muscles of the eye,—wherever the eye possesses protecting motions, we find the same arrangement of the third, fourth, and sixth nerves, from man downwards.†

Surely it is time to read off the anatomy of the nervous system,—to seek for the relations of parts through their nerves,—to ask ourselves why there are such deviations in their course,—and why these deviations are constant, not in individuals only, but in the different classes of animals? If, with this view, we ask ourselves why the facial nerve takes a course different from the fifth, the functions of the part to which it is distributed do sufficiently inform us, that the features must be joined in sympathy or unison with the act of respiration. If we inquire why its branches reach to the eyelids, to the very part through which the branches of the fifth pass, we have only to notice the necessity for a guarding action of the eyelids in all excited conditions of the respiratory system. I need not here repeat my former observations.

---

* Where there is a retractor muscle, this abducens nerve supplies it, which strengthens the supposition of a relation between the retraction of the eye and its simultaneous direction inwards.

† Taking the facts of the anatomy into account, and the actions of these muscles, the subject becomes of great interest, as connected with the expression in the eye.

In the same manner we may interpret the course of the spinal accessory nerve, or the reverted course of the recurrent of the *par vagum*.

In looking generally to the remarkable deviations in the course of the nerves, we shall find that they are confined to those which join distant parts in the act of breathing, or modify the act of breathing, as in speaking, swallowing, &c. No such irregularities are found in the system of nerves which minister to voluntary motion and sensation. They are distributed with a perfect symmetry and regularity.

And in the orbit, if we take away the respiratory of the face (the facialis), and the nerves resulting from that connection, viz. the fourth and sixth, the intricacy of the orbitary nerves is removed; there would remain one for vision, another for common sensibility and a third for motion.

In conclusion, and in explanation of the marked difference in the origin of the nerves of the spine and of the encephalon, we shall find that it is principally owing to the columns of motion and sensation.

1. All the nerves of Sense,—the olfactory, optic,

auditory, not excepting the gustatory, though running into the base of the brain, must deviate from the anterior column, which is that of motion; and, accordingly, they twist round that column to enter directly into the sensorium (as the olfactory does), or to associate with the column of sensation, like the optic tractus, and roots of the auditory nerve.

2. The next source of irregularity of form and apparent intricacy in the base of the brain, is a consequence of the various sensibilities and active powers of the eye and its appendages, which require no fewer than six nerves to this one organ! Hence the ophthalmic of the fifth nerve, in addition to the proper optic nerve,—hence the motor independently of the fifth,—hence the sixth and the fourth, to associate the deep and superficial muscles of the eye and eyelids.

3. Another source of intricacy is the intrusion, as it were, of the fifth nerve among those of the encephalon. The fifth, a nerve of double root, a sensitive and motor nerve, a nerve with a distinct ganglion on its posterior root, I early announced to be a spinal nerve, that is, the anterior or (in the human body) the superior of the spinal nerves. This nerve not only giving motion to the jaws,, but being the nerve of sensibility, mingles its branches with every other nerve, goes every where in the head and face, and enters into every organ, and is therefore a source of exceeding great intricacy, until the just principle be obtained.*

4. Lastly, a main source of intricacy in the nerves of the base of the brain, and of the whole nervous

---

* The discovery of this fact has been caught at by men, as incapable of the induction which led to it, as of following it up in its consequences.

system, is the existence of a distinct source of motion independent of volition, and yet necessarily conjoined to it,—a source of power which shall govern the act of respiration, and yet permit a union of the apparatus of breathing with those of speech; for example, the necessity of joining the motion of the features with the pneumatic office of the lungs, being the cause of that deviation which we perceive in the facial nerve from those of simple volition.

In short, the double origin and double function of the nerves of the spine is the reason of their uniformity and simplicity of distribution. The nerves of the brain differ from those of the spine, and from each other, inasmuch as each has a peculiar endowment, and necessarily a distinct origin. They therefore vary in course and distribution, and hence their apparent intricacy.

EXPLANATION OF PLATE XVI.

[illegible]
[illegible]